



STAR

**Center for Satellite
Applications and Research**

formerly ORA — Office of Research and Applications



The ABI on GOES-R

Timothy J. Schmit

NOAA/NESDIS/Satellite Applications and Research

Advanced Satellite Products Branch (ASPB)

Kaba Bah, Mathew M. Gunshor, Jun Li, Scott Bachmeier, William Straka,
etc.

CIMSS, Madison, WI

James J. Gurka, Steve Goodman, etc.

GOES-R Program Office



**Eighth Annual Symposium on
Future Operational Environmental
Satellite Systems**

*New Orleans, LA
24 January 2011*



UW-Madison

Also Thanks to...

- Achtor, Tom; Ackerman, Steve; Antonelli, Paolo; Aune, Bob; Baggett, Kevin; Baum, Bryan; Ellrod, Gary; Feltz, Joleen; Feltz, Wayne; Frey, Rich; Griffin, Michael K.; Gumley, Liam; Heymann, Roger; Hillger, Don; Huang, Allen; Key, Jeff; Knuteson, Bob; Mecikalski, John; Menzel, Paul; Moeller, Chris; Mosher, Fred; Nelson, James; Nasiri, Shaima; Olander, Tim; Plokhenko, Youri; Prins, Elaine; Rabin, Bob; Revercomb, Hank; Schmidt, Chris; Schreiner, Tony; Seemann-Wetzel, Suzanne; Sieglaff, Justin; Strabala, Kathy; Sun, Fengying; Tobin, Dave; Velden, Chris; Wade, Gary; Whittaker, Tom; Woolf, Hal, Jason Otkin, etc.
- Mitch Goldberg, AWG co-chairs, AWG Leads, Jaime Daniels, Walter Wolf, GPO, Jordan Gerth, Chian-Yi Liu, Jason Otkin, Thomas Greenwald, Monica Coakley, GOES-R flight/ground, Bill Smith, ASPB, PG, SSEC data center, CWG, NASA, ITT, etc.
- You!

Outline

- Current GOES Imager and Sounder
 - GOES-14/15
- ABI (Advanced Baseline Imager)
 - Temporal
 - Spatial
 - Spectral
- Summary
 - More information
 - Questions



GOES-15

GOES-13/14/15 have similar instruments to GOES-8-12, but on a different spacecraft bus.

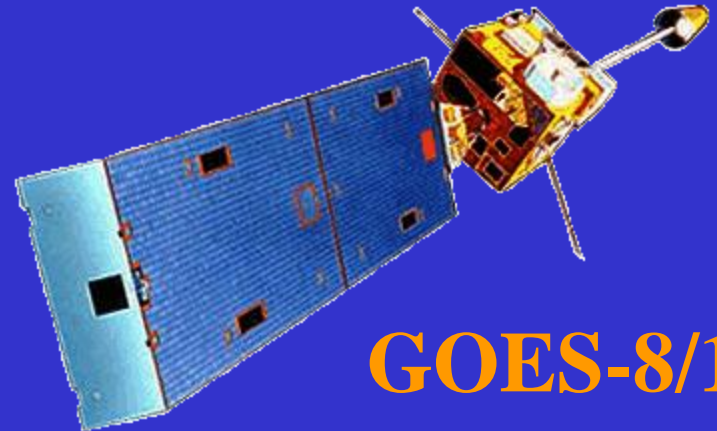
Spring and fall eclipse outages will be avoided by larger onboard batteries.

Improved navigation

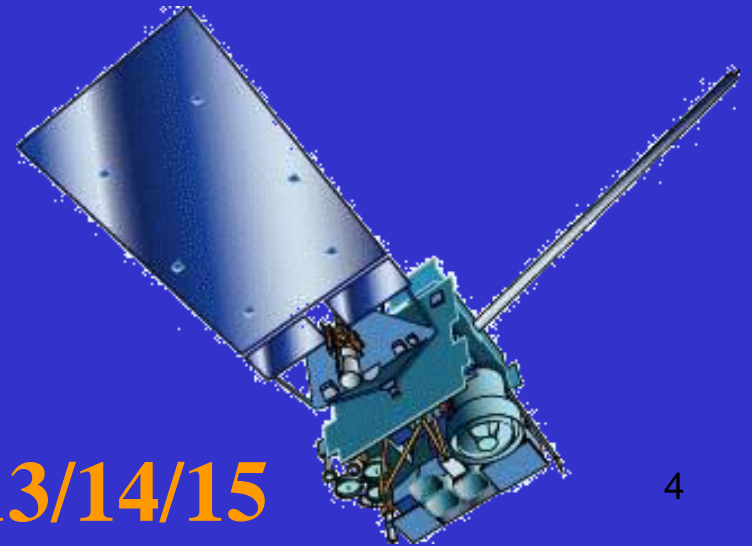
Improved radiometrics

Similar stray light to GOES-13/14

Operational on Dec 6th, 2011

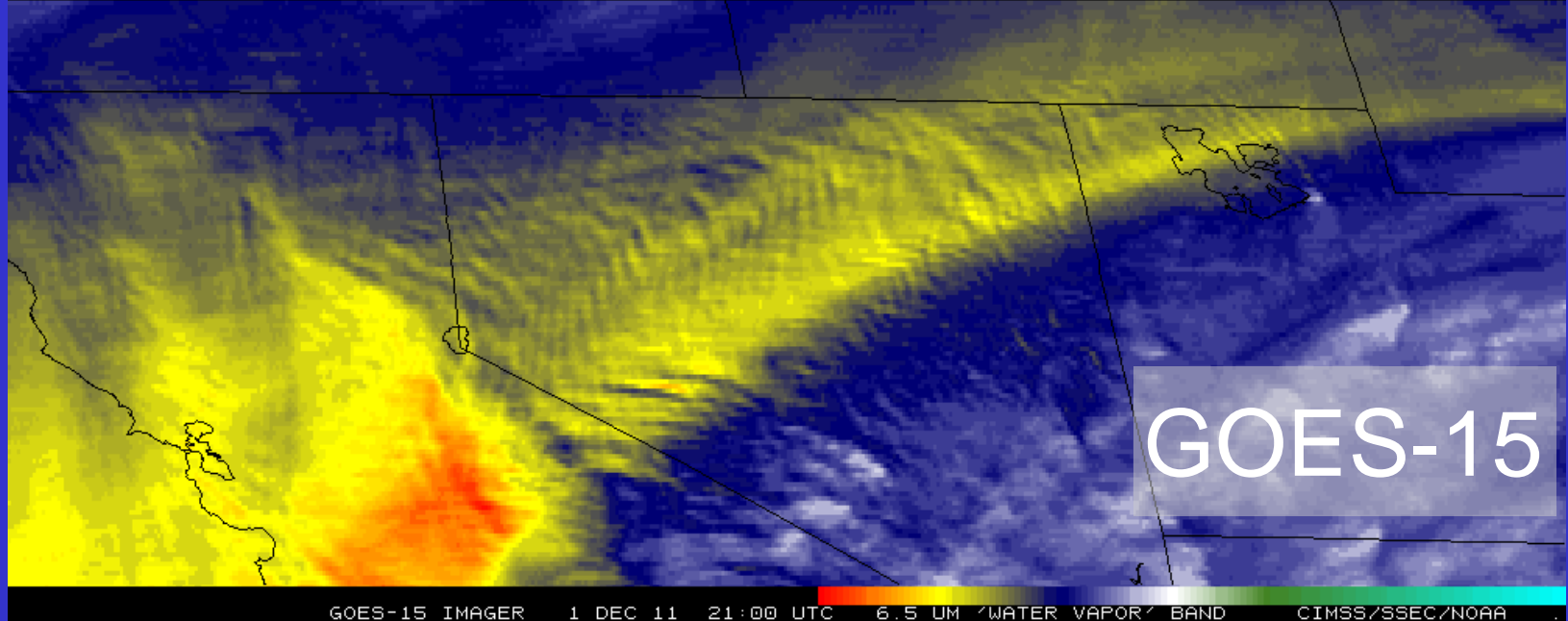
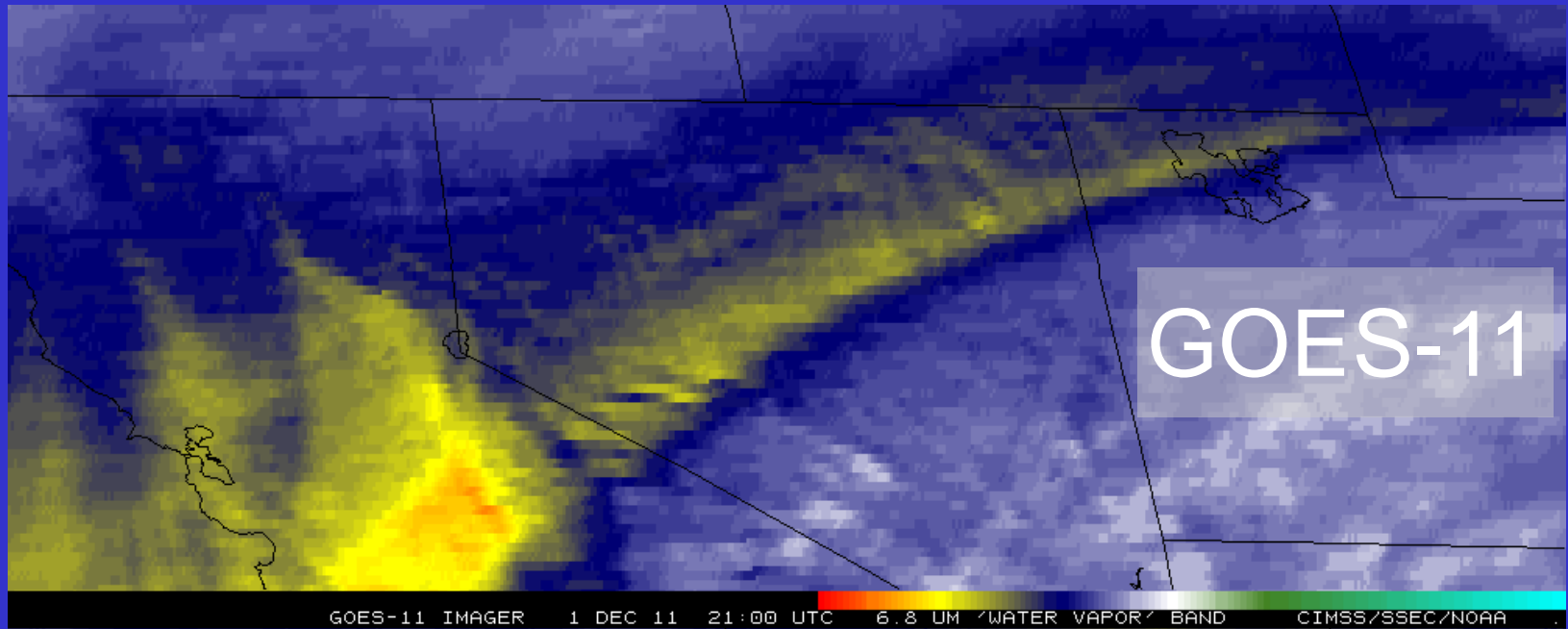


GOES-8/12

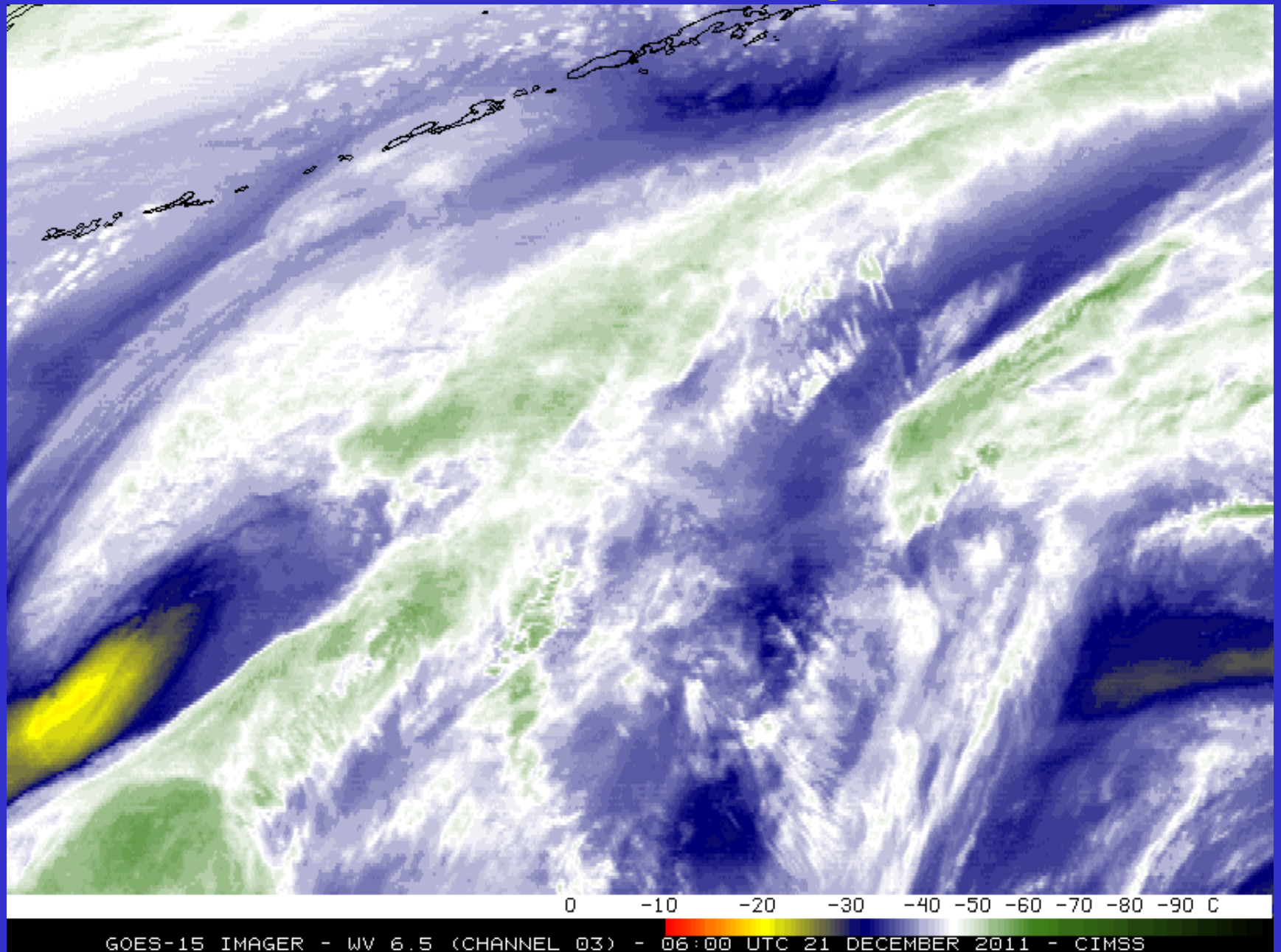


GOES-13/14/15

Improved GOES-15 WV imagery

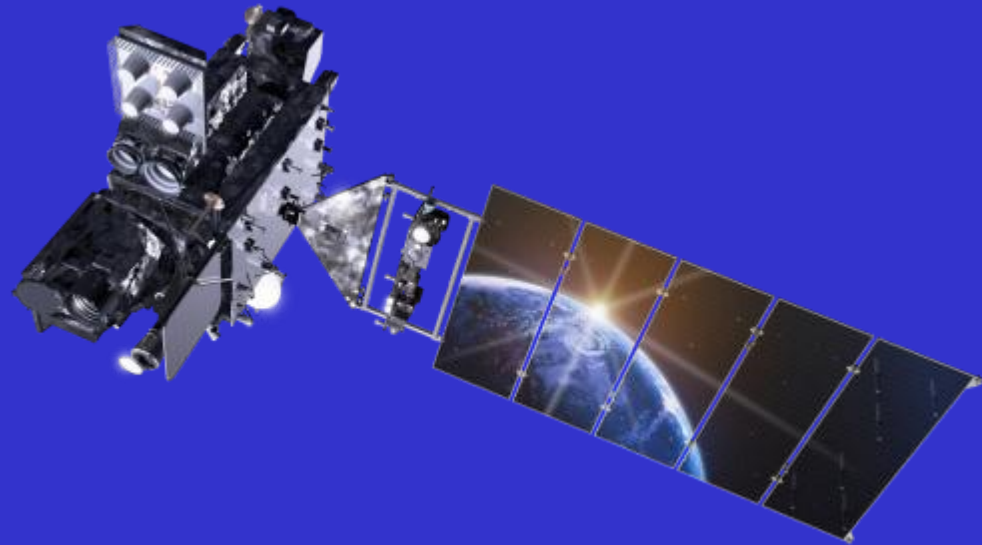


GOES-15 imagery



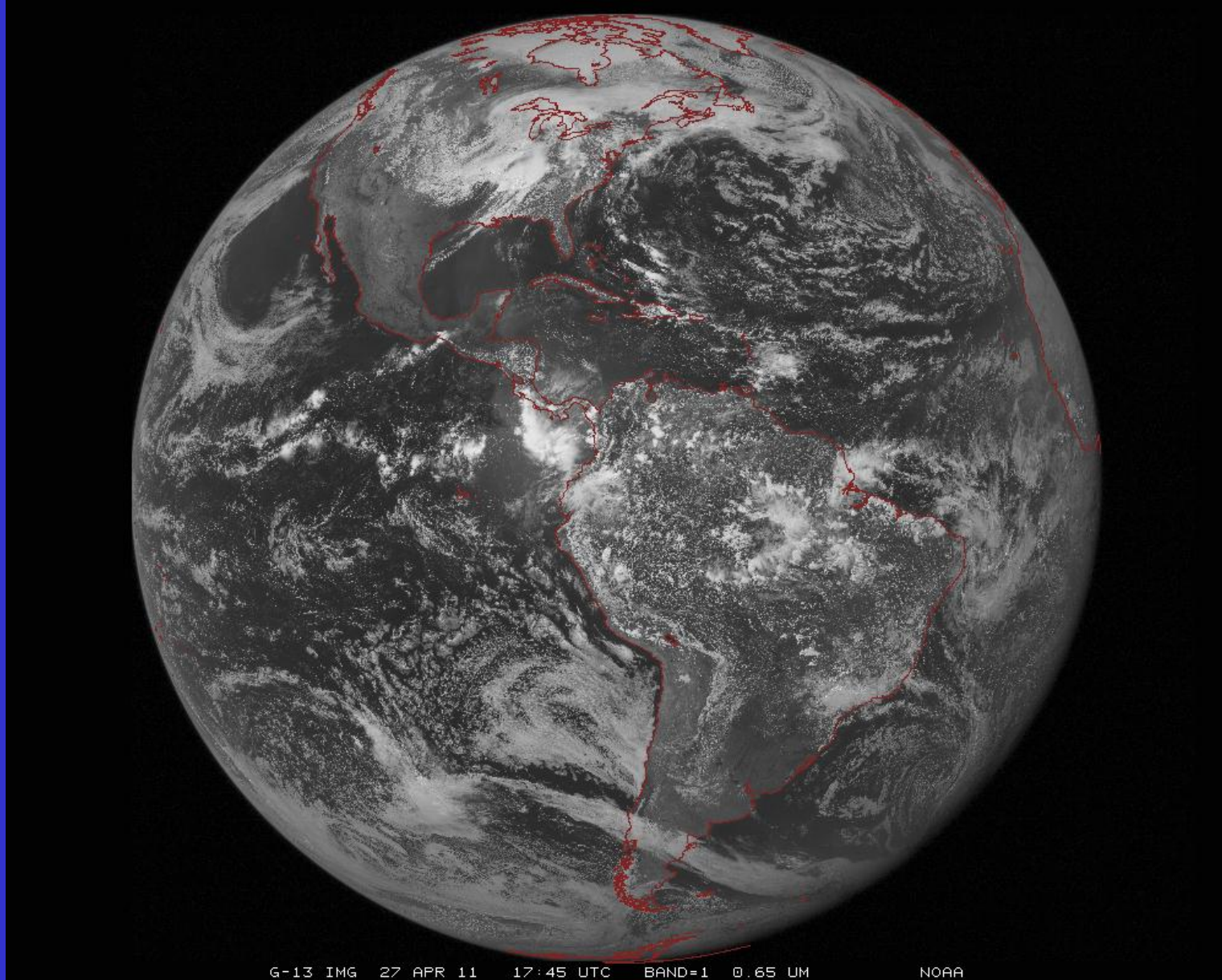
Outline

- Current GOES Imager and Sounder
 - GOES-14/15
- ABI (Advanced Baseline Imager)
 - Temporal
 - Spatial
 - Spectral
- Summary
 - More information
 - Questions



The Advanced Baseline Imager:

	ABI	Current
Spectral Coverage		
	16 bands	5 bands
Spatial resolution		
0.64 μm Visible	0.5 km	Approx. 1 km
Other Visible/near-IR	1.0 km	n/a
Bands ($>2 \mu\text{m}$)	2 km	Approx. 4 km
Spatial coverage		
Full disk	4 per hour	Scheduled (3 hrly)
CONUS	12 per hour	~4 per hour
Mesoscale	Every 30 sec	n/a
Visible (reflective bands)		
On-orbit calibration	Yes	No

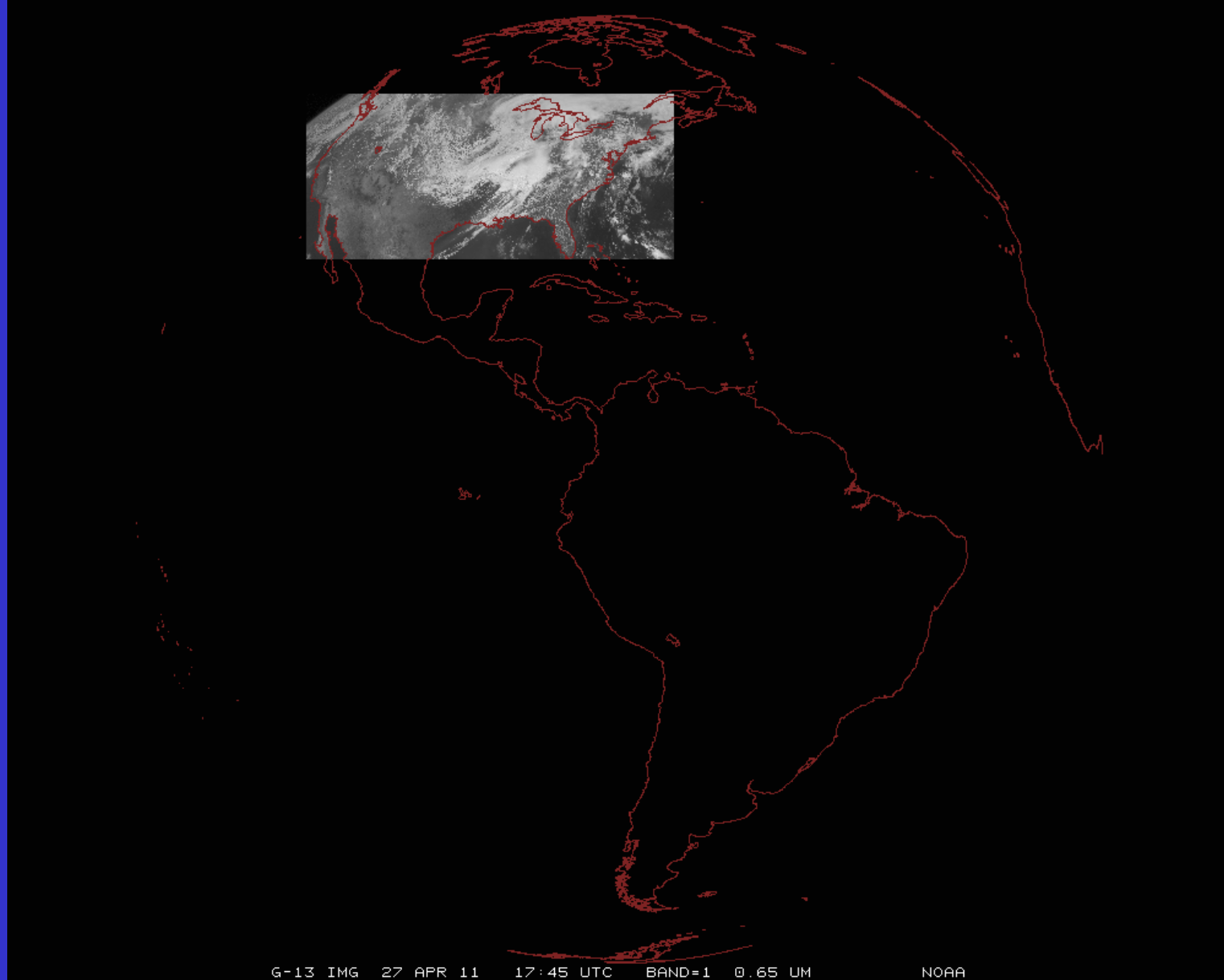


ABI
scans
about 5
times
faster
than the
current
GOES
imager

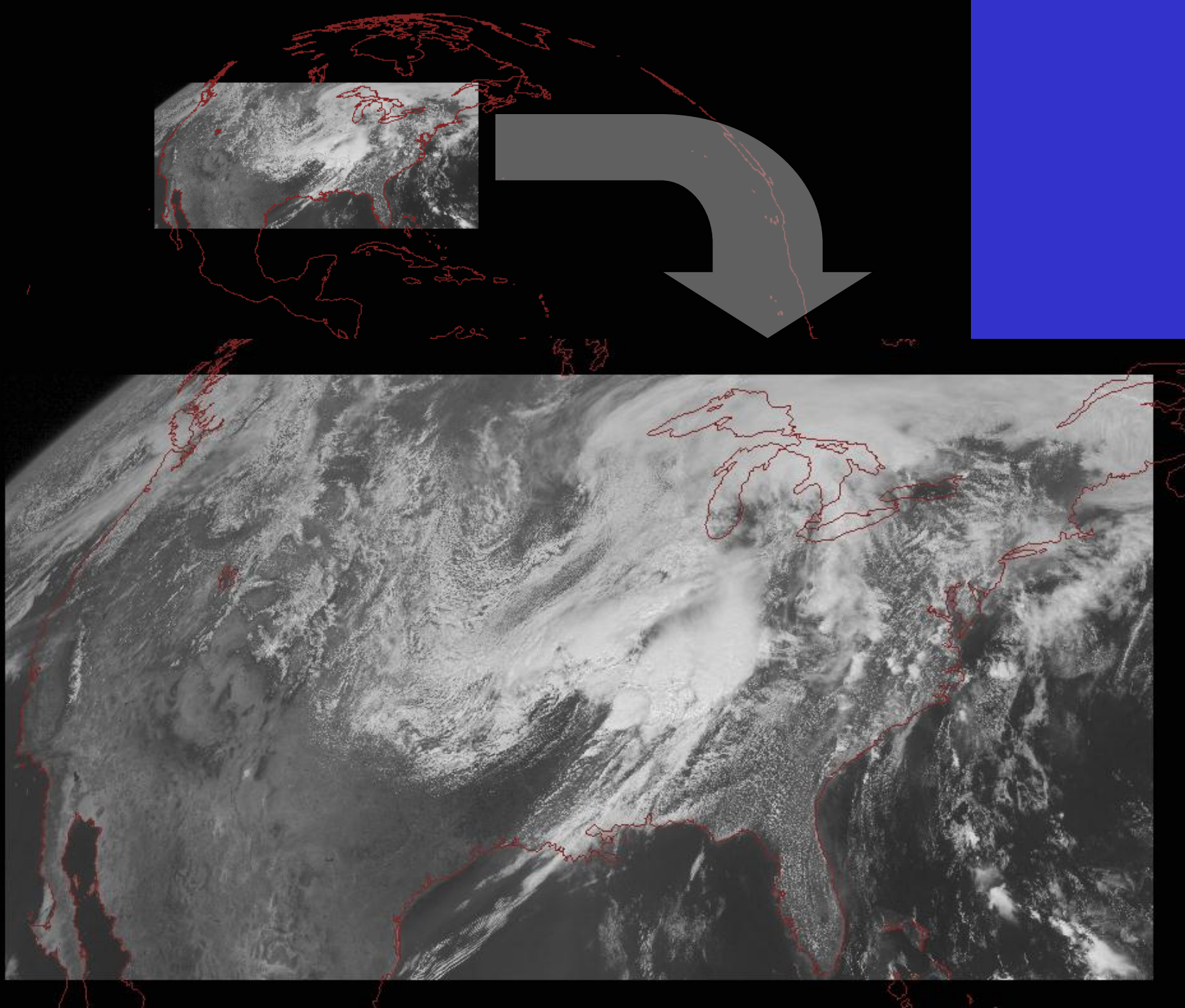
G-13 IMG 27 APR 11 17:45 UTC BAND=1 0.65 UM NOAA

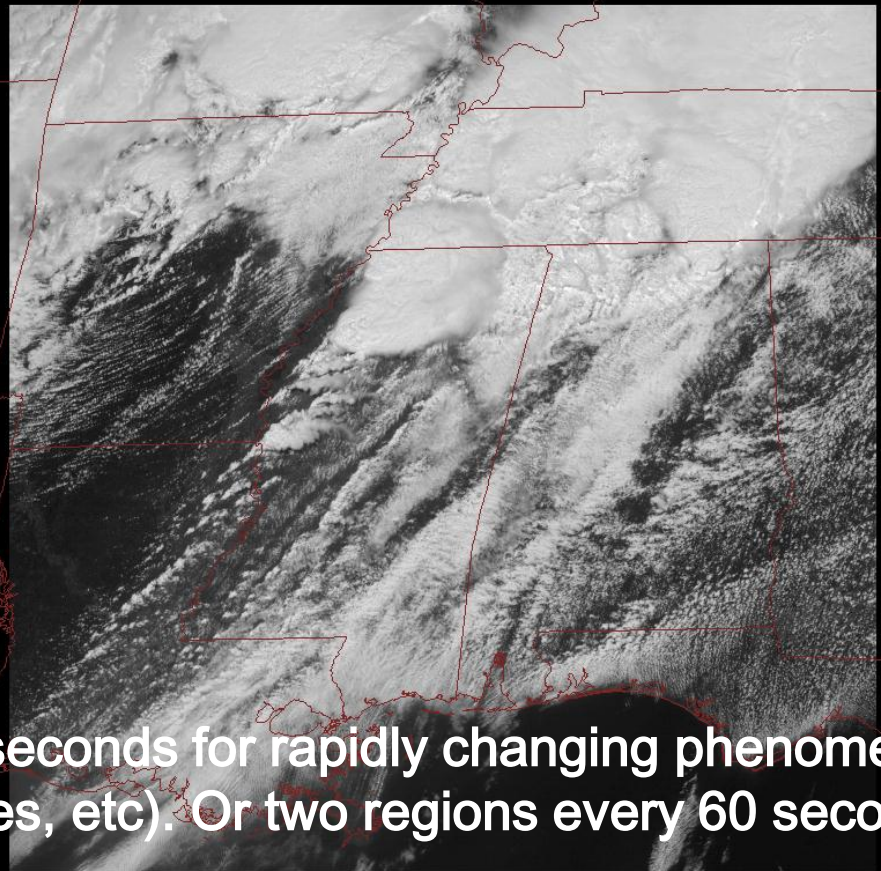
There are two anticipated scan modes for the ABI:

- Full disk images every 15 minutes + 5 min CONUS images + mesoscale.
- or - Full disk every 5 minutes.



ABI can offer Continental US images every 5 minutes for routine monitoring of a wide range of events (storms, dust, clouds, fires, winds, etc).
This is every 15 or 30 minutes with the current GOES in routine mode.



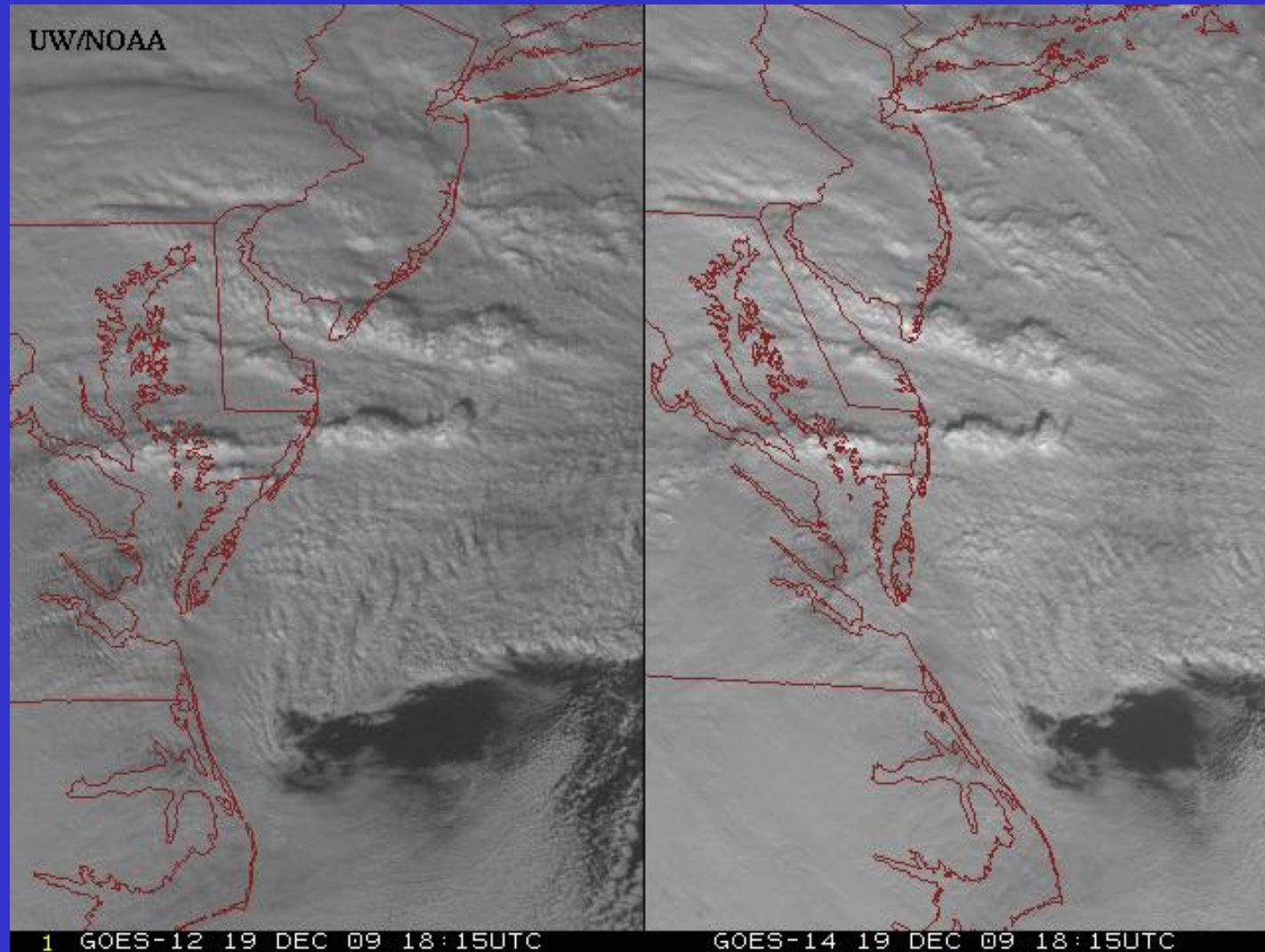


G-13 IMG 27 APR 11 1

Mesoscale images every 30 seconds for rapidly changing phenomena (thunderstorms, hurricanes, fires, etc). Or two regions every 60 seconds.

G-13 IMG 27 APR 11 17:45 UTC BAND=1 0.65 UM NOAA

GOES-14: Sample “1-min” imagery



GOES-12

GOES-14

- Visible data from the GOES-14 NOAA Science Test, lead by Hillger and Schmit¹³
- Can these type loops validate meso-scale models?

ABI to Imager Noise Comparison

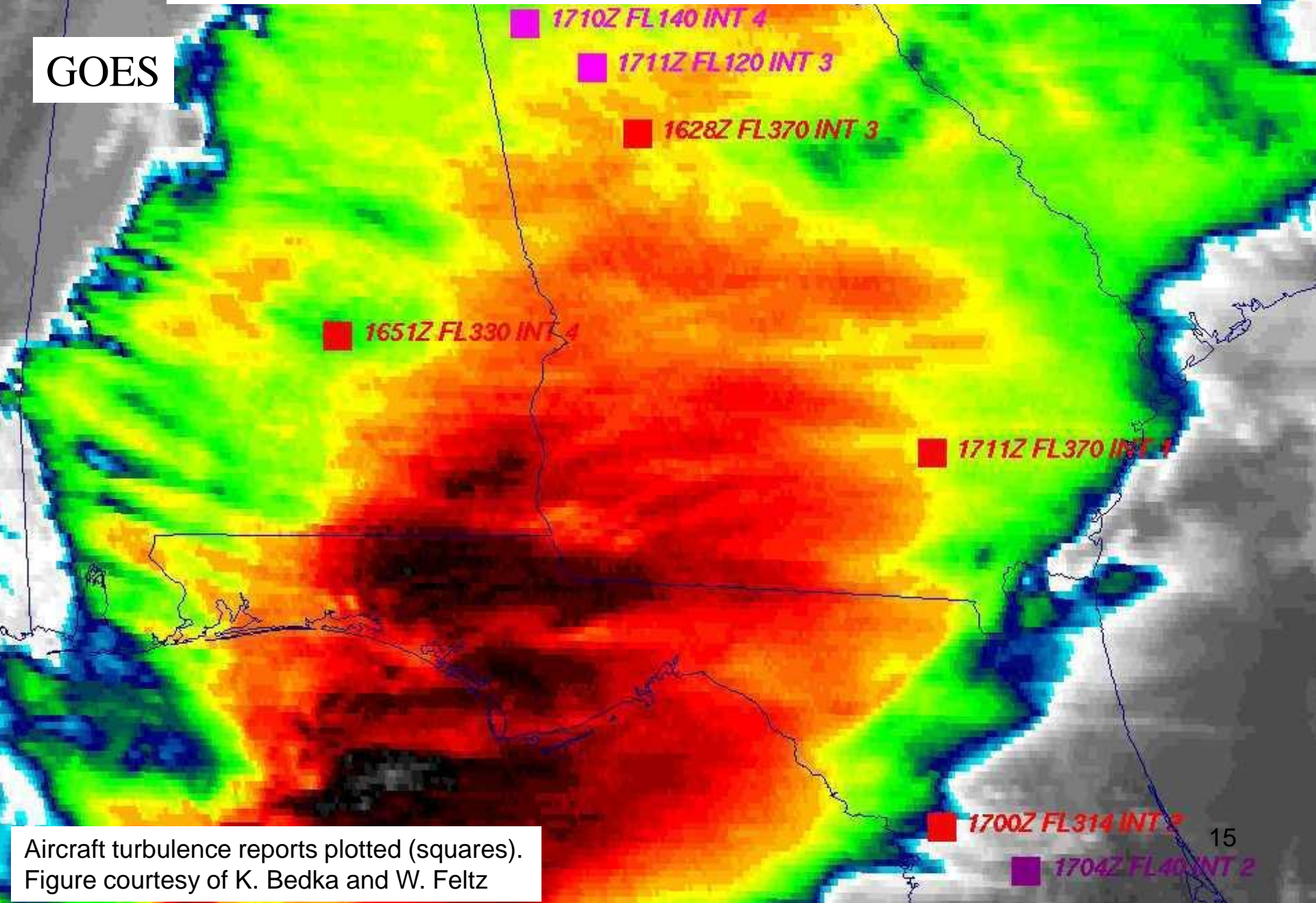
* From ITT at GUC7

ABI				GOES			-12	-15
#	Freq. (um)	Spec	Worst Case Estimate*	#	Freq (um)	Spec	Measured (PLT)	Measured (PLT)
7	3.9	0.1	0.10	2	3.9	1.4	0.130	0.063
8	6.185	0.1	0.06					
9	6.95	0.1	0.09	3	6.x	1.0	0.15	0.17
10	7.34	0.1	0.11					
11	8.5	0.1	0.04					
12	9.61	0.1	0.04					
13	10.35	0.1	0.05					
14	11.2	0.1	0.04	4	10.7	0.35	0.11	0.06
15	12.3	0.1	0.05	5	12.0	0.35	-	-
16	13.3	0.3	0.14	6	13.3	0.32	0.19	0.13

Similar instrument noise, even with 4-16 times finer spatial resolutions!

GOES: Cannot monitor waves

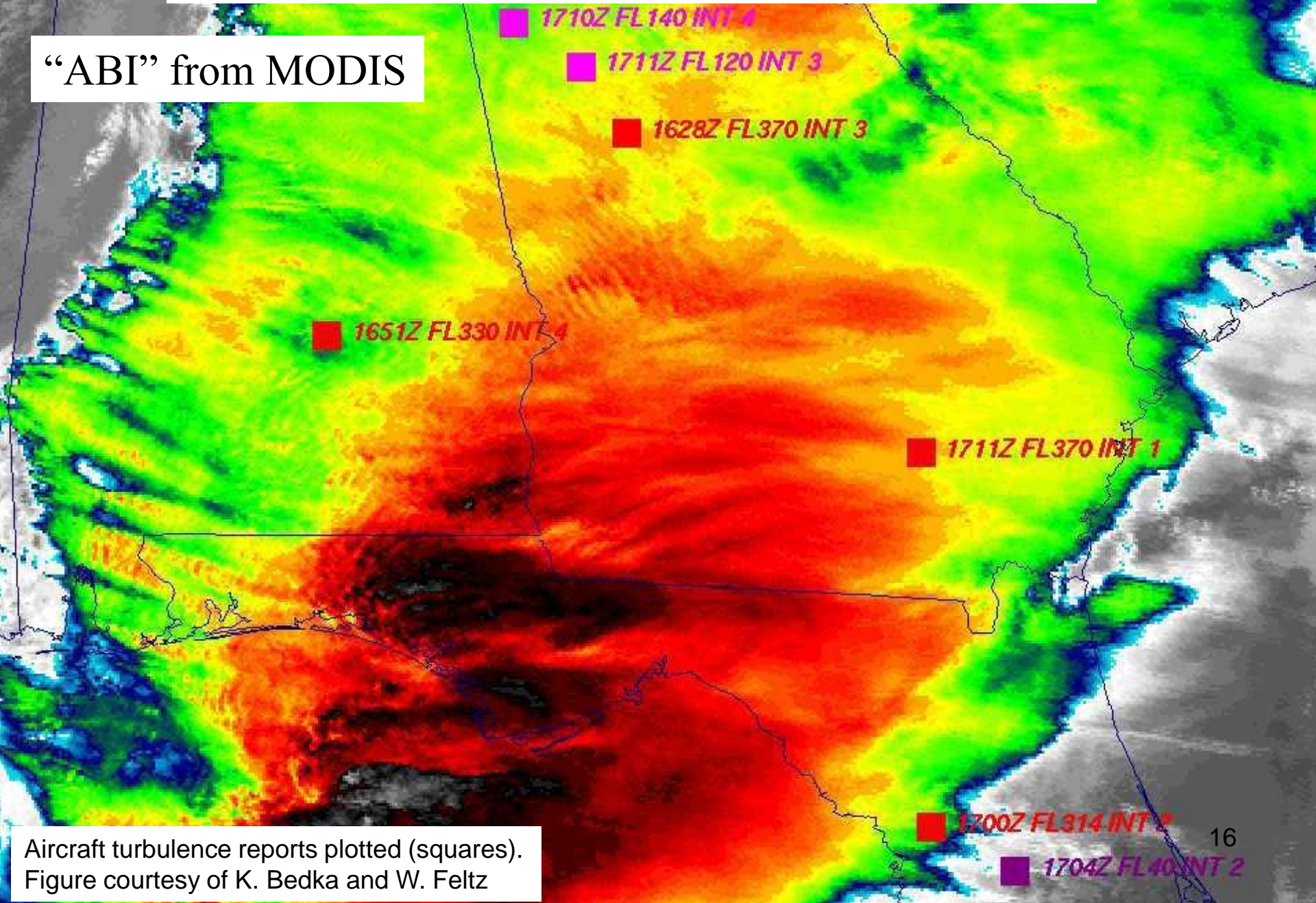
GOES



Aircraft turbulence reports plotted (squares).
Figure courtesy of K. Bedka and W. Feltz

ABI: Can monitor waves

“ABI” from MODIS

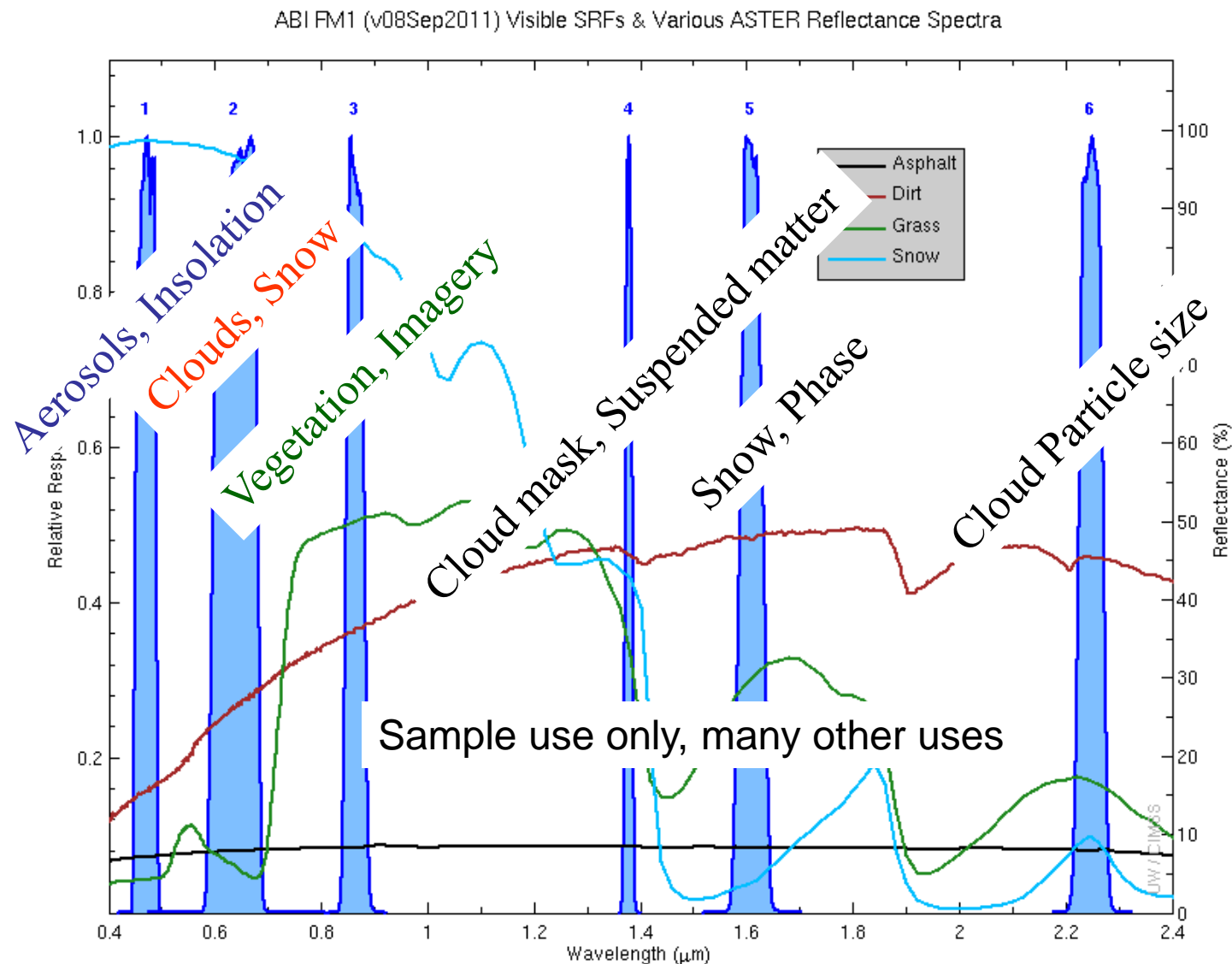


Aircraft turbulence reports plotted (squares).
Figure courtesy of K. Bedka and W. Feltz

ABI Visible/Near-IR Bands

Future GOES imager (ABI) band	Wavelength range (μm)	Central wavelength (μm)	Nominal subsatellite IGFOV (km)	Sample use
1	0.45–0.49	0.47	1	Daytime aerosol over land, coastal water mapping
2	0.59–0.69	0.64	0.5	Daytime clouds fog, insolation, winds
3	0.846–0.885	0.865	1	Daytime vegetation/burn scar and aerosol over water, winds
4	1.371–1.386	1.378	2	Daytime cirrus cloud
5	1.58–1.64	1.61	1	Daytime cloud-top phase and particle size, snow
6	2.225–2.275	2.25	2	Daytime land/cloud properties, particle size, vegetation, snow

Visible and near-IR channels on the ABI

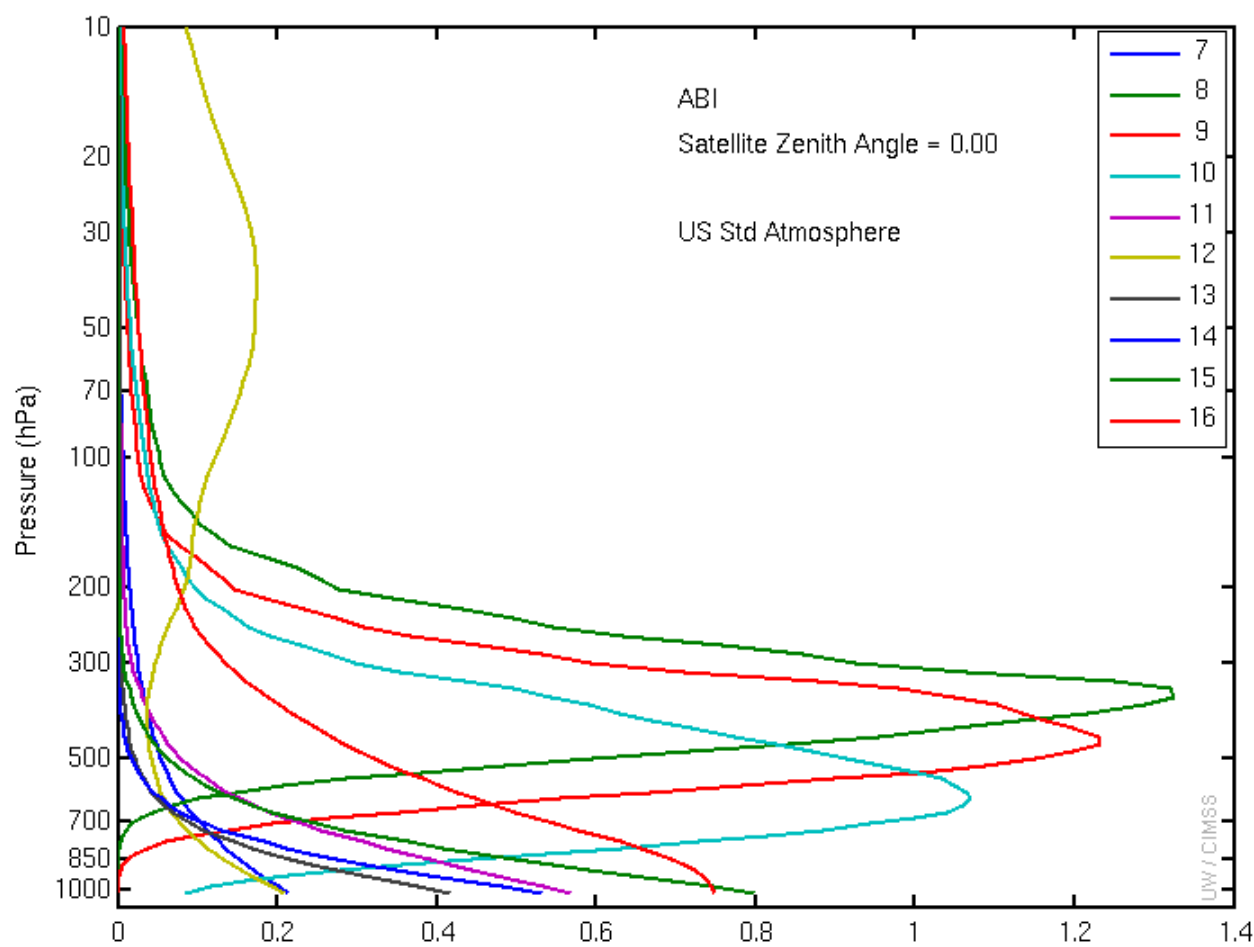


The ABI visible and near-IR bands have many uses.

ABI IR Bands

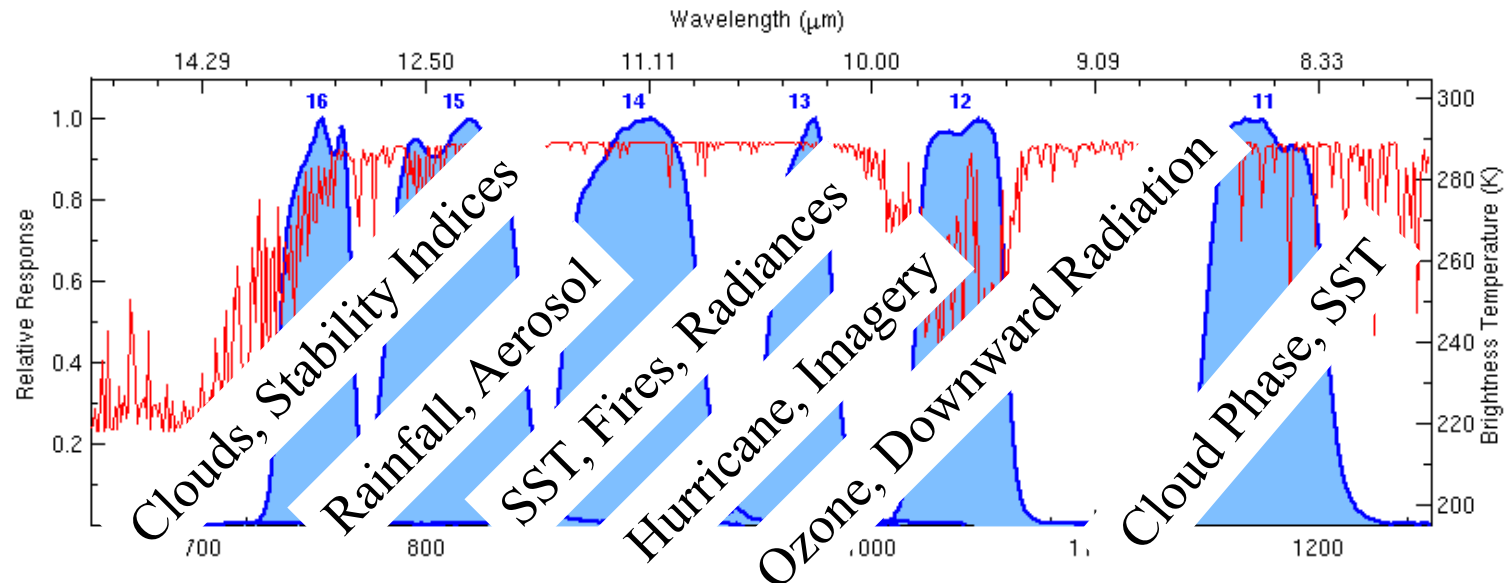
7	3.80–4.00	3.90	2	Surface and cloud, fog at night, fire, winds
8	5.77–6.6	6.19	2	High-level atmospheric water vapor, winds, rainfall
9	6.75–7.15	6.95	2	Midlevel atmospheric water vapor, winds, rainfall
10	7.24–7.44	7.34	2	Lower-level water vapor, winds, and SO ₂
11	8.3–8.7	8.5	2	Total water for stability, cloud phase, dust, SO ₂ rainfall
12	9.42–9.8	9.61	2	Total ozone, turbulence, and winds
13	10.1–10.6	10.35	2	Surface and cloud
14	10.8–11.6	11.2	2	Imagery, SST, clouds, rainfall
15	11.8–12.8	12.3	2	Total water, ash, and SST
16	13.0–13.6	13.3	2	Air temperature, cloud heights and amounts

ABI IR Weighting Functions

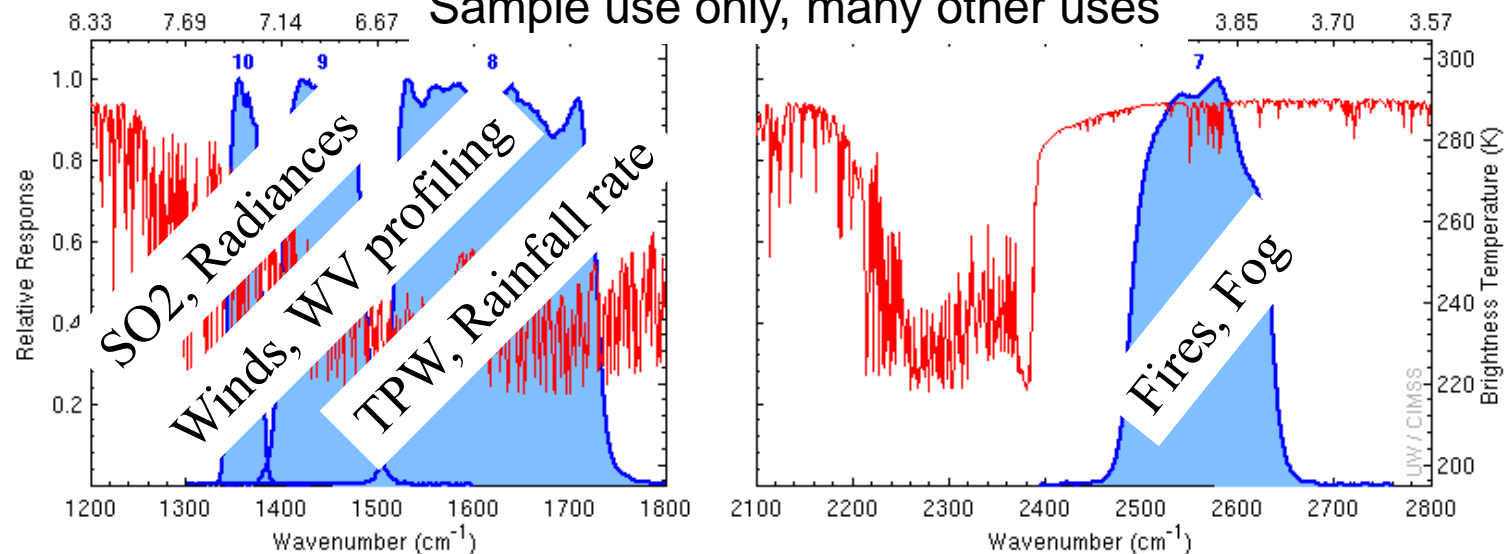


The IR channels on the ABI

ABI FM1 (v08Sep2011) SRFs & US Std Atms Brightness Temperature Spectrum

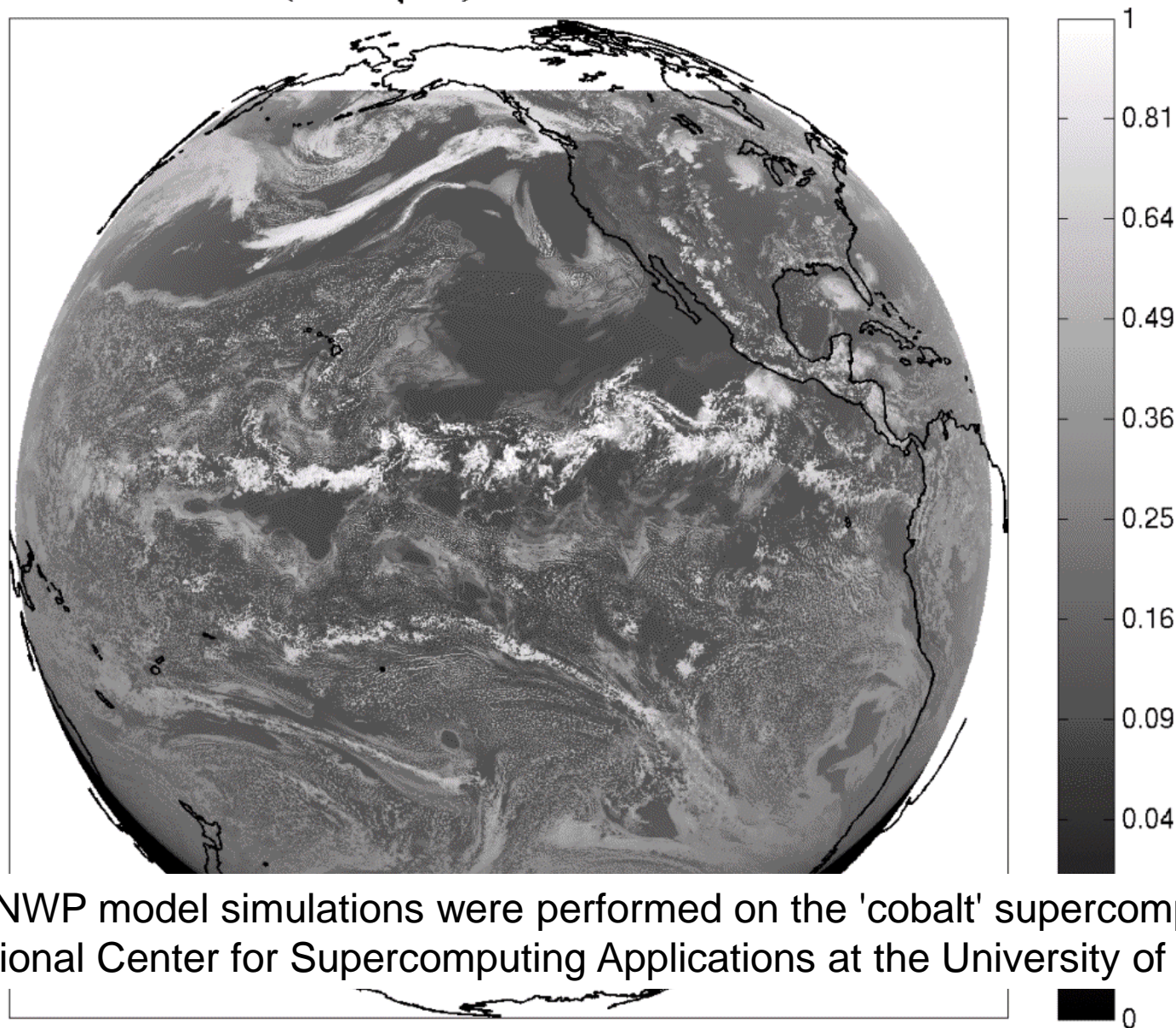


Sample use only, many other uses



ABI has many more bands than the current operational GOES imagers.

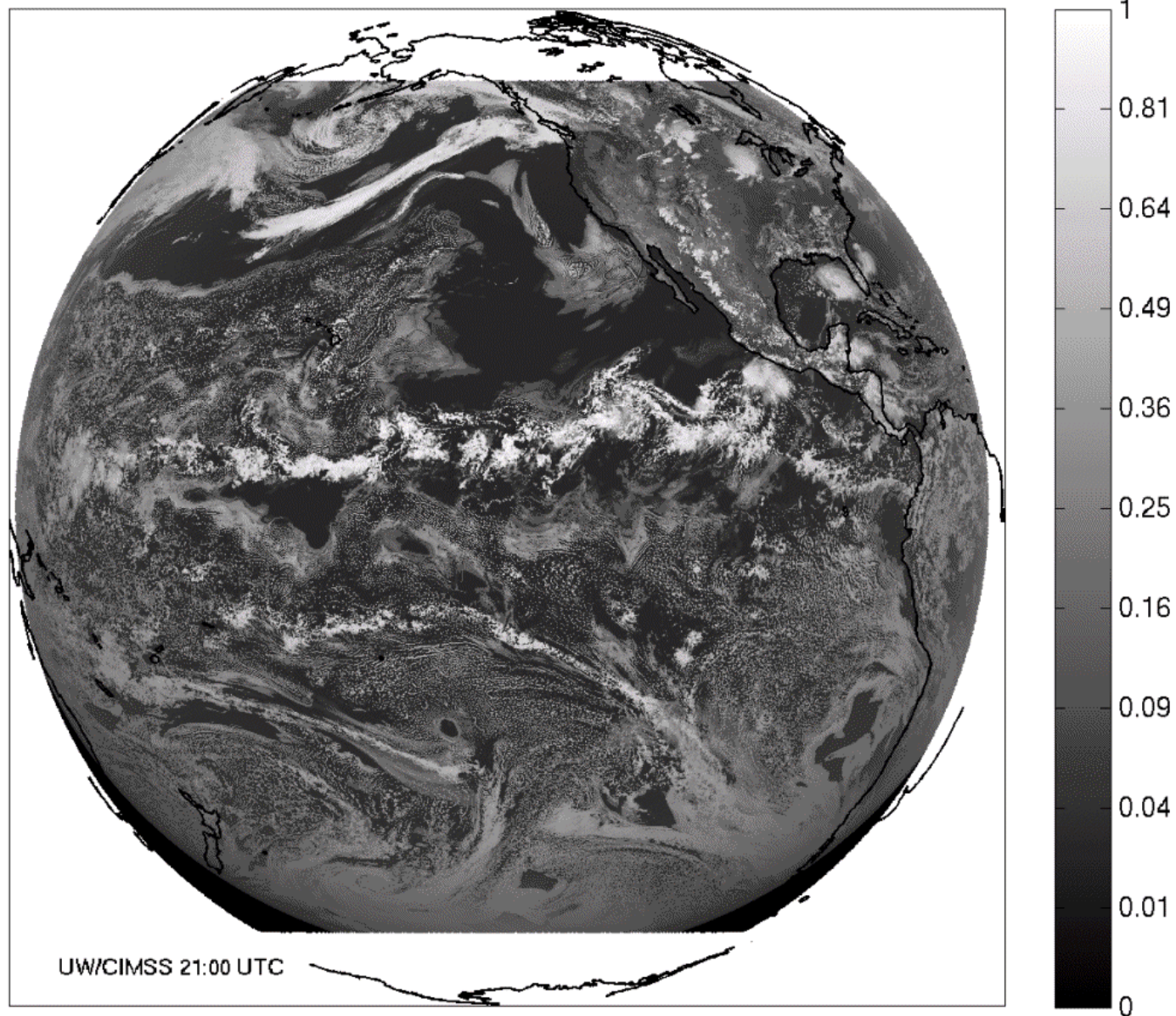
ABI band 1 (0.47 μm) reflectance 2008-06-26



These NWP model simulations were performed on the 'cobalt' supercomputer at the National Center for Supercomputing Applications at the University of Illinois.

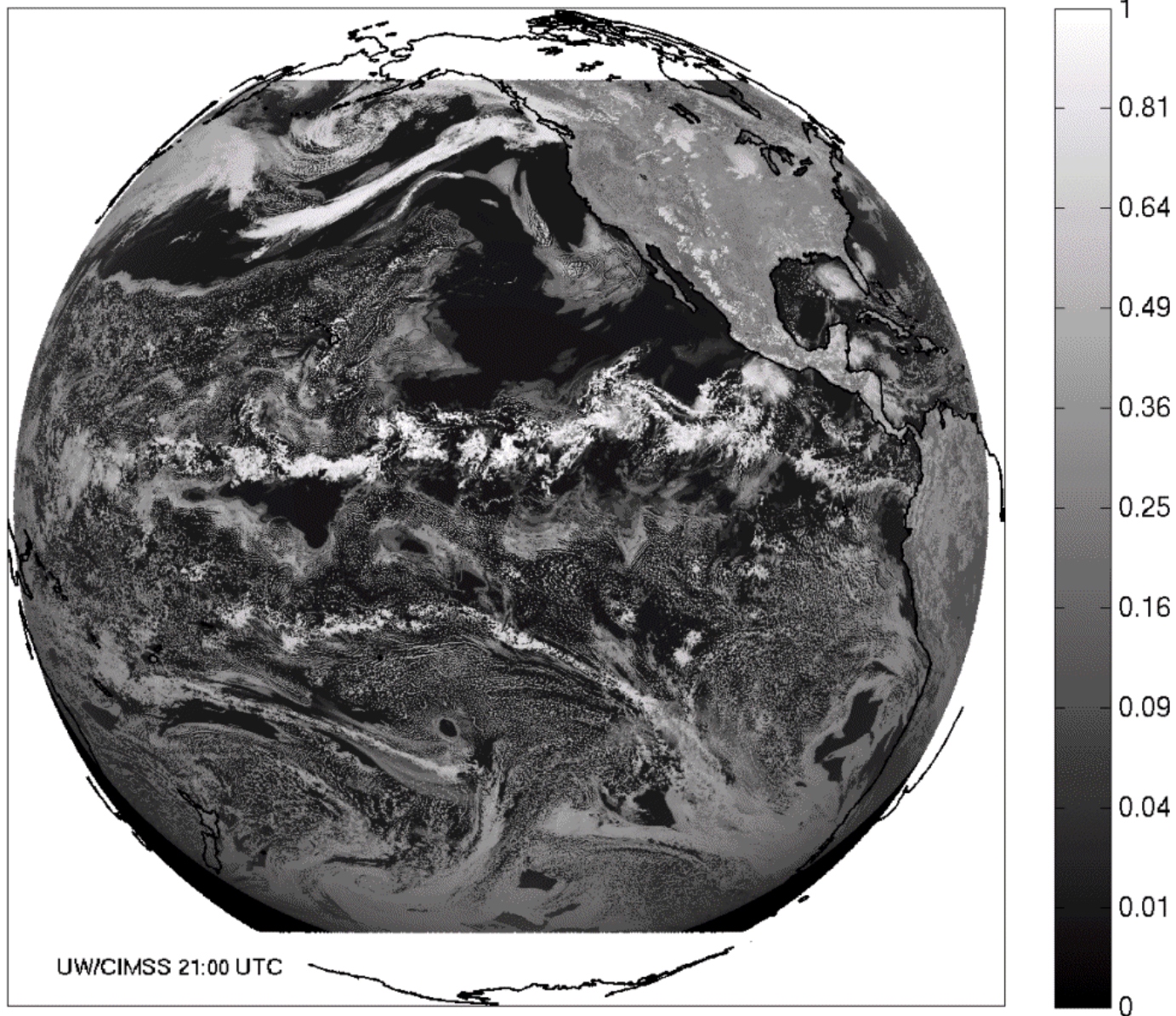
Band 1: Daytime “Blue” band – aerosols, solar insolation, snow cover

ABI band 2 (0.64 μm) reflectance 2008-06-26



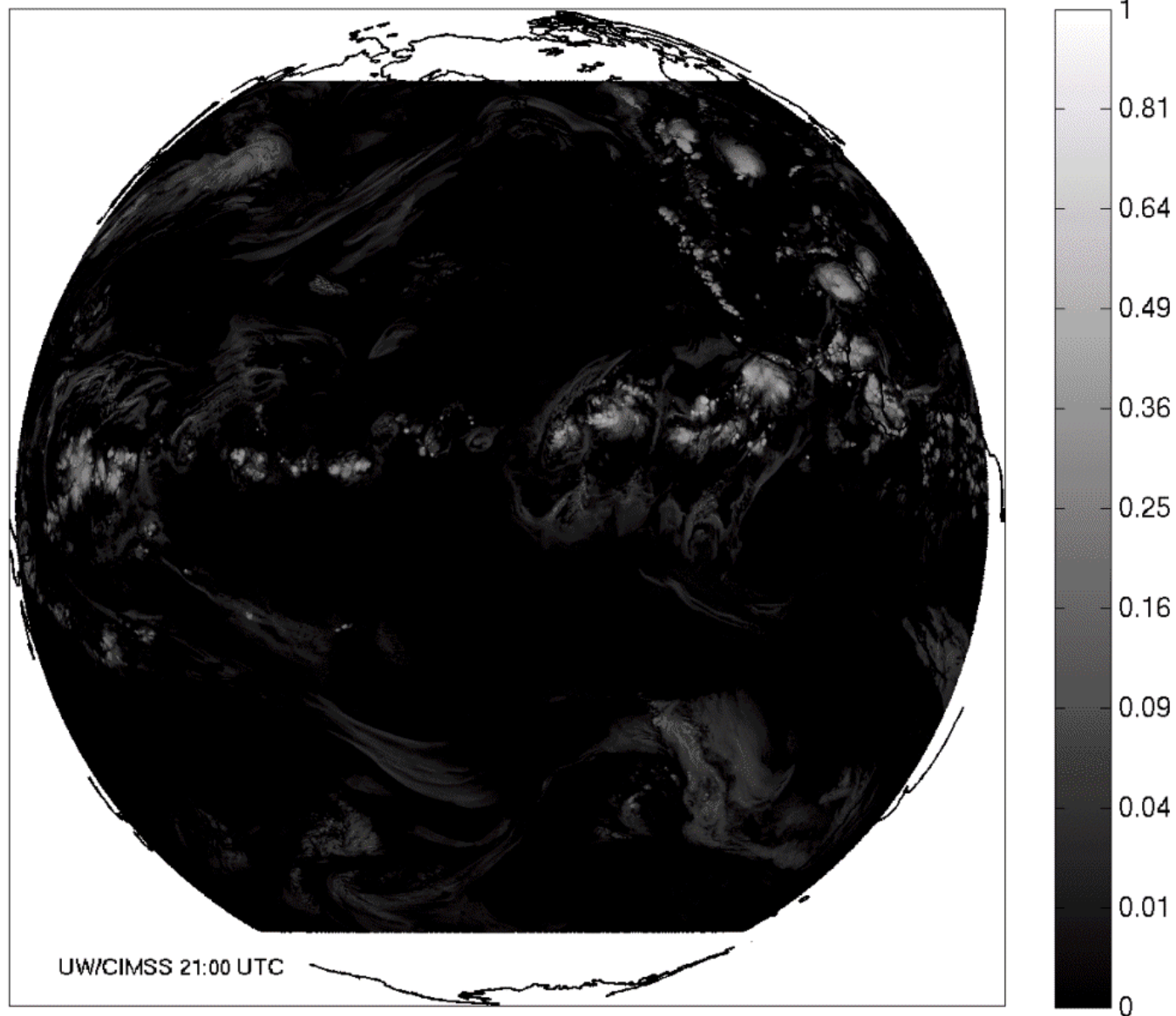
Band 2: Daytime “Red” band – clouds, cloud-mask, optical depth, winds, etc. ²³

ABI band 3 (0.87 μm) reflectance 2008-06-26



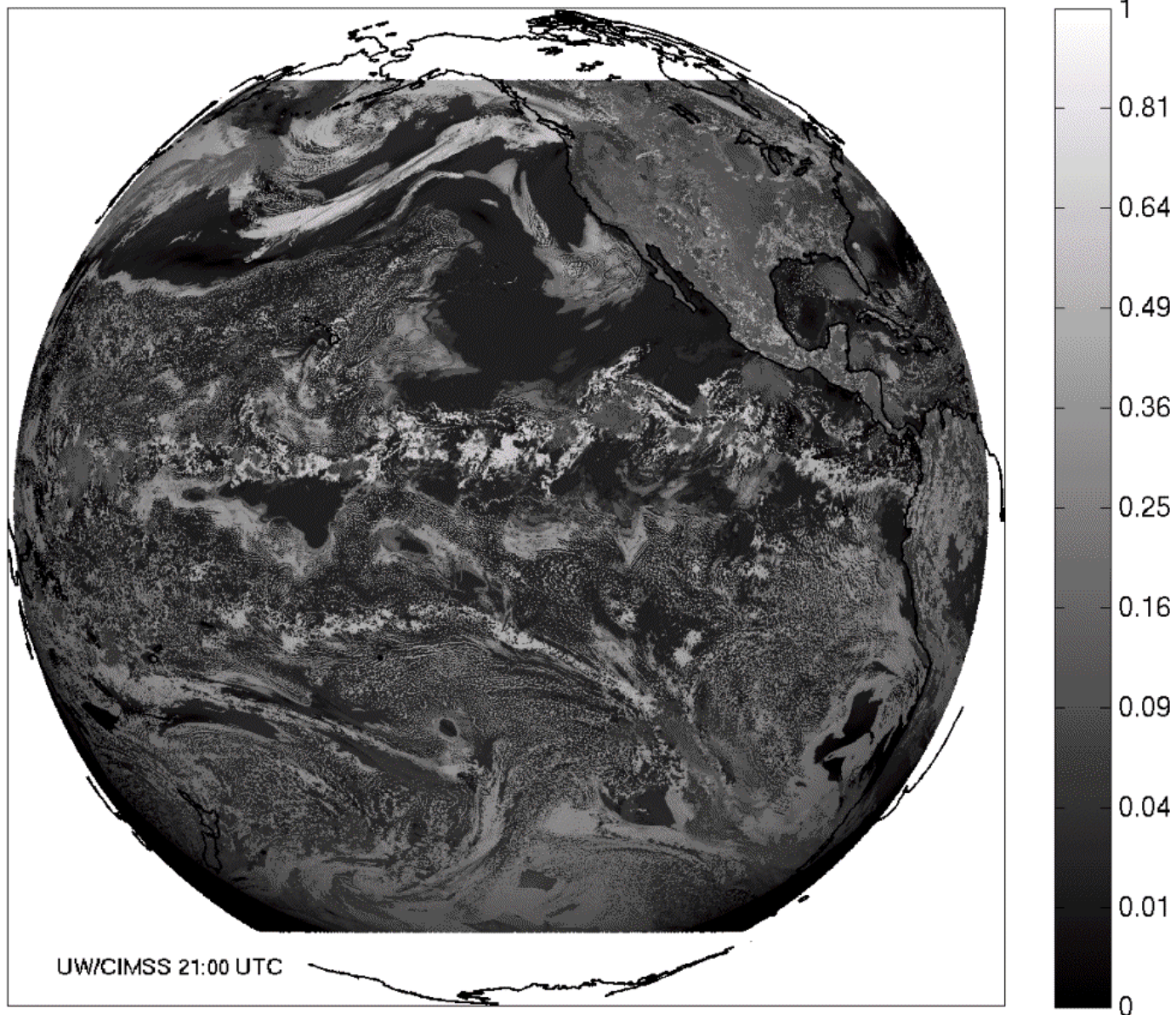
Band 3: Daytime “Veggie” band – NDVI, solar insolation, snow cover

ABI band 4 (1.38 μm) reflectance 2008-06-26



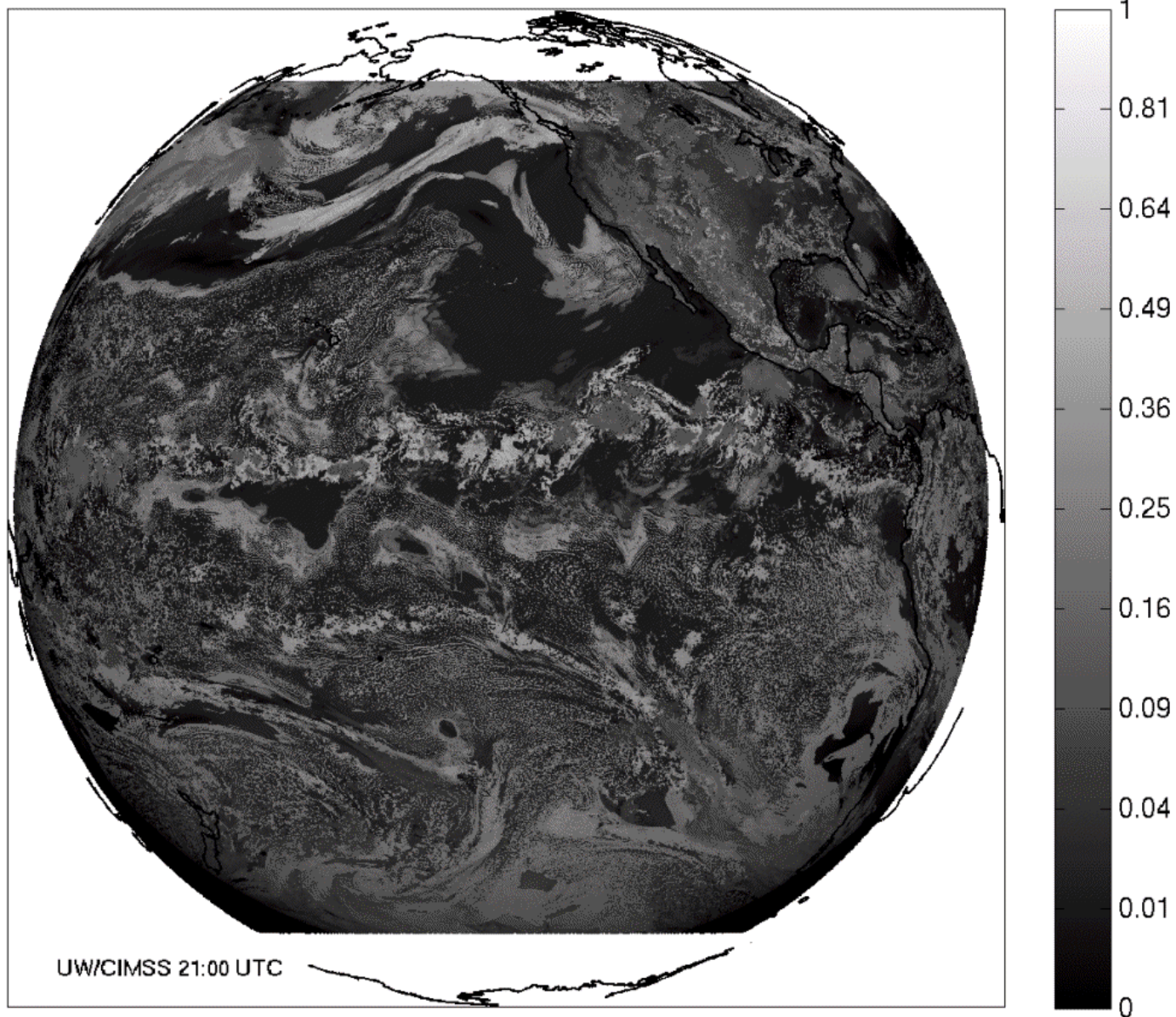
Band 4: Daytime “Cirrus” band – cloud mask, aerosol detection

ABI band 5 (1.61 μm) reflectance 2008-06-26



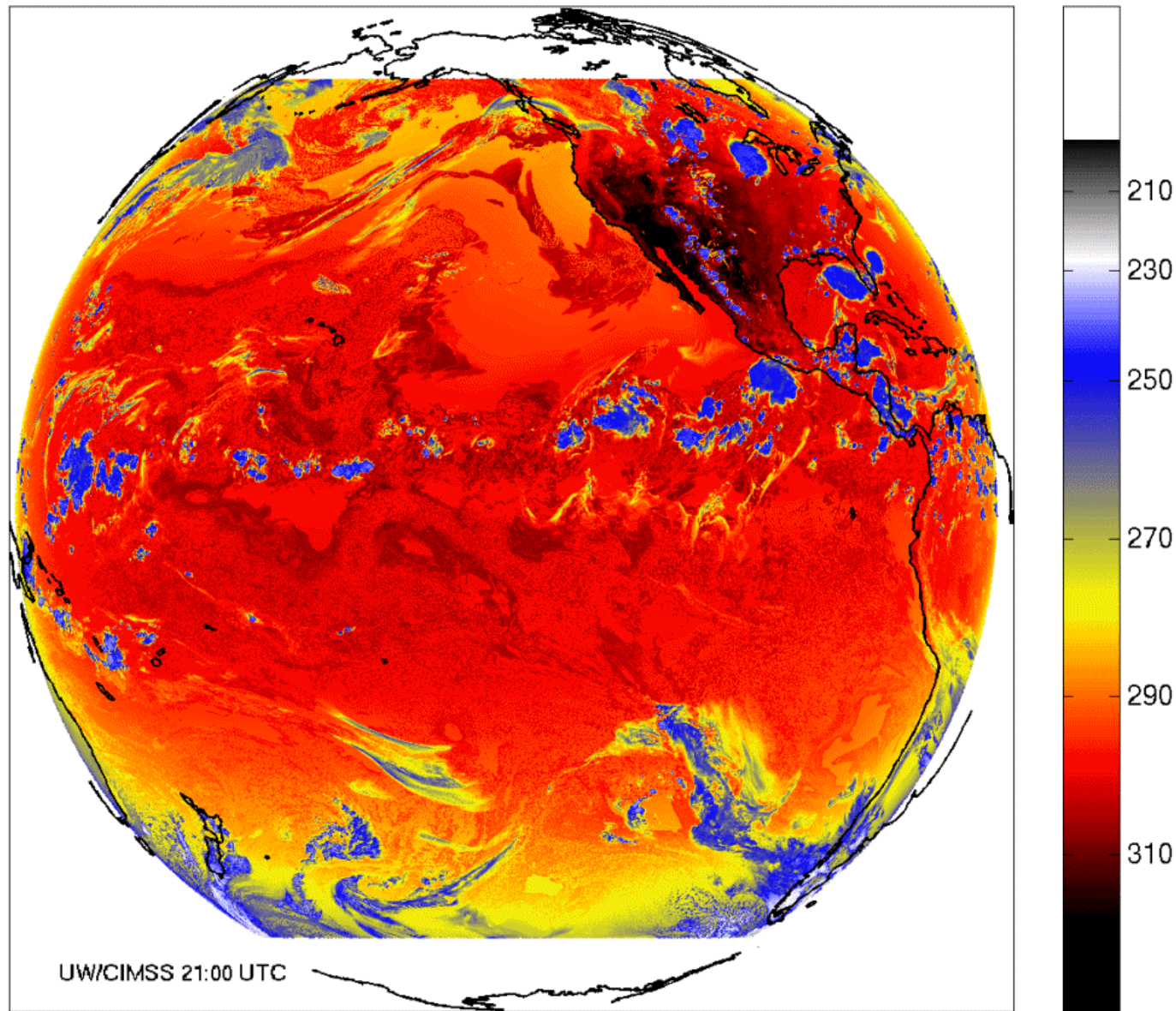
Band 5: Daytime “Snow” band – snow cover, cloud mask, etc.

ABI band 6 (2.25 μm) reflectance 2008-06-26



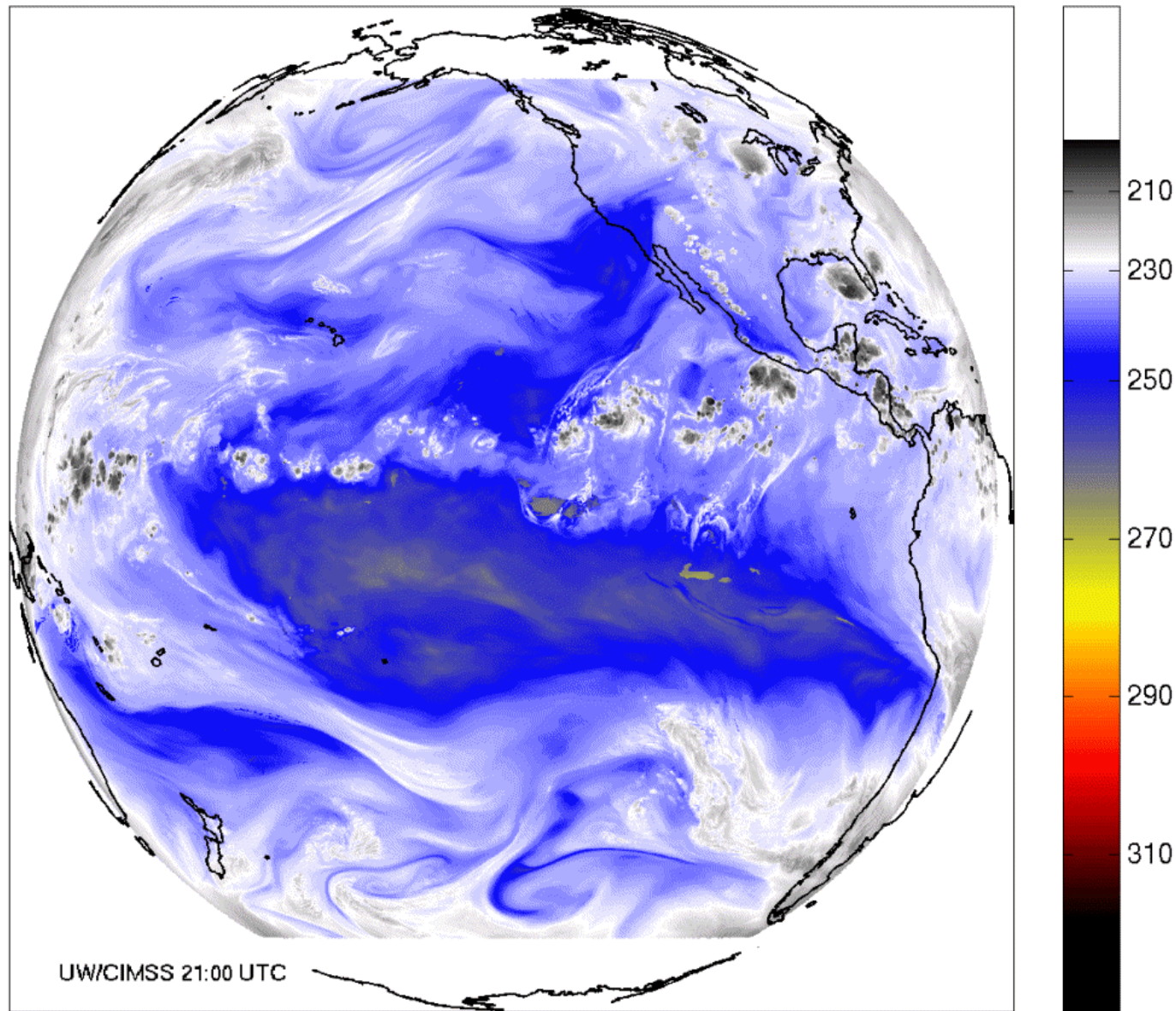
Band 6: Daytime “Cloud-top phase” band – cloud particle size, snow cover 27

ABI band 7 (3.90 μm) BT (K) 2008-06-26



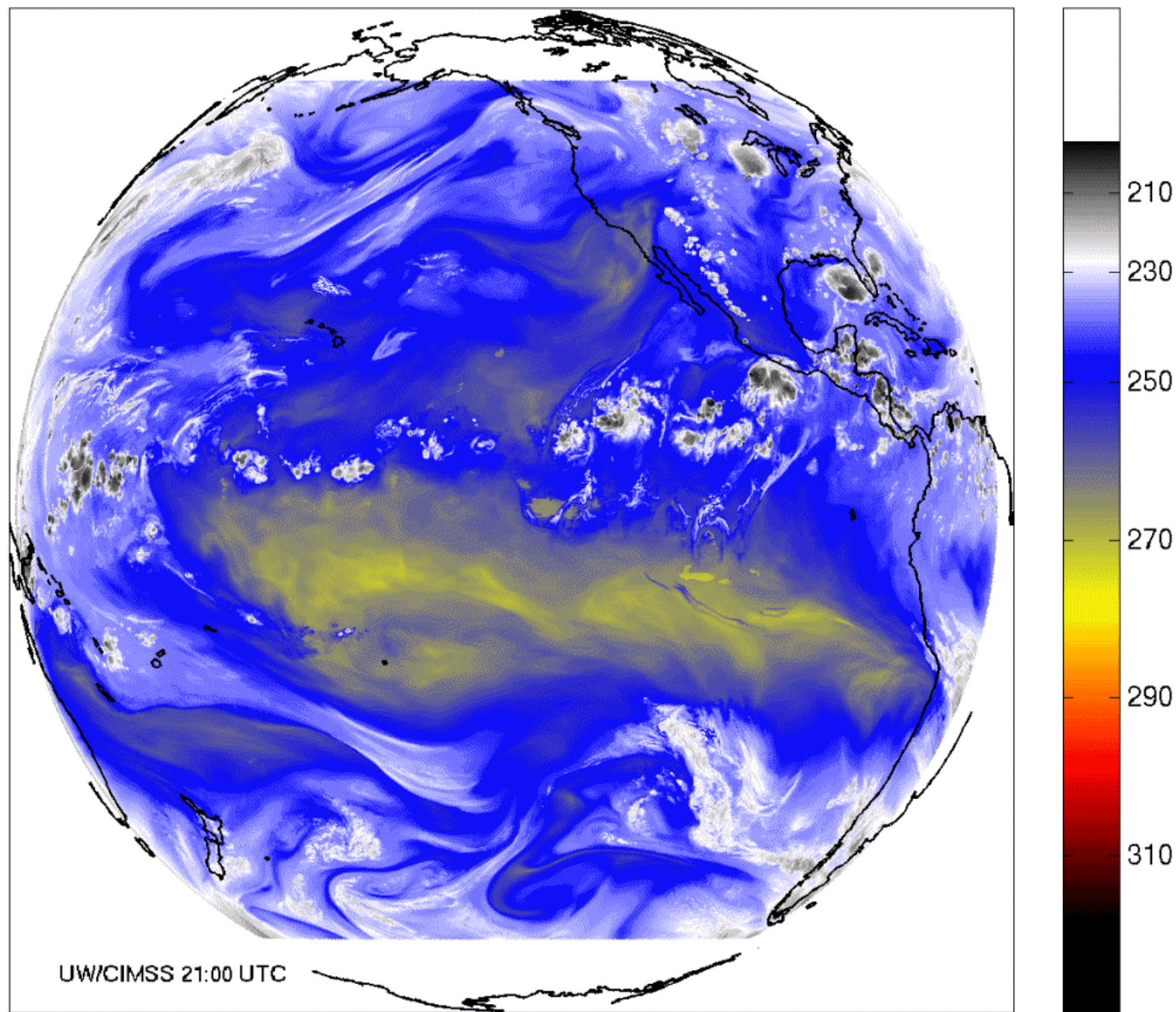
Band 7: Shortwave IR window band - fog, fires, winds, SST, etc.

ABI band 8 (6.19 μm) BT (K) 2008-06-26



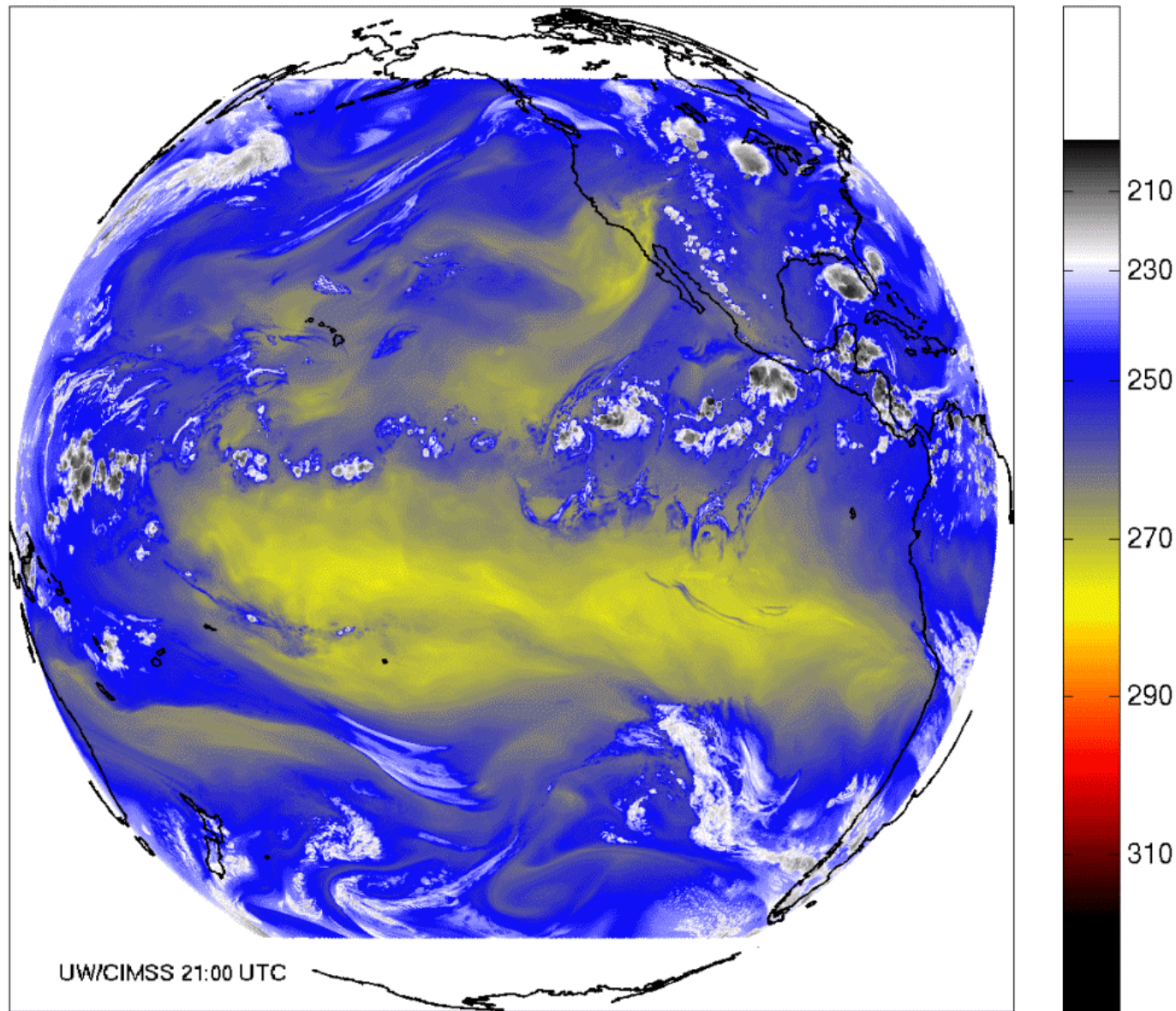
Band 8: Upper-level tropospheric water vapor band – moisture, flow, winds 29

ABI band 9 (6.95 μm) BT (K) 2008-06-26



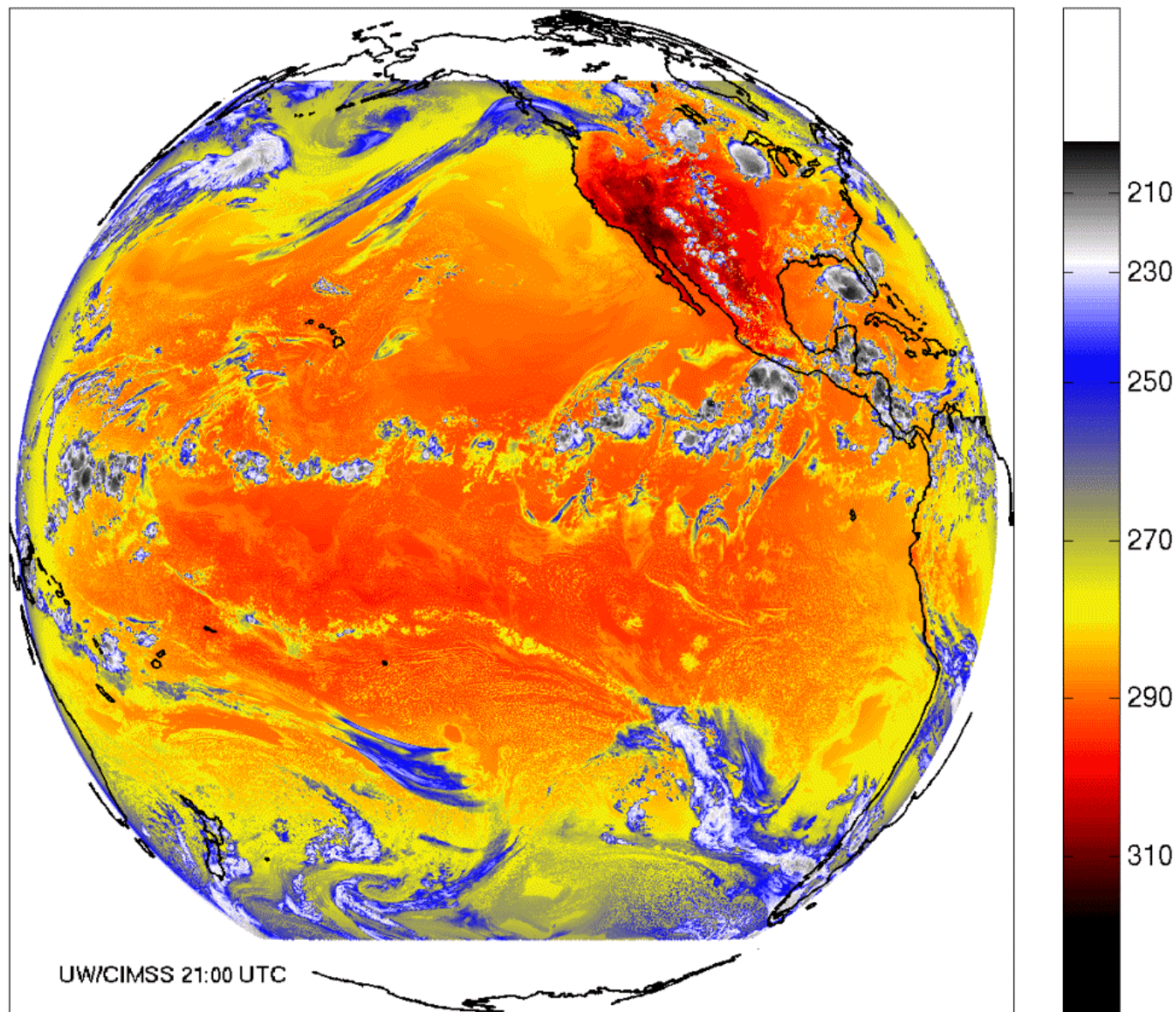
Band 9: Upper/mid-level tropospheric water vapor band – moisture, flow, winds 30

ABI band 10 (7.34 μm) BT (K) 2008-06-26



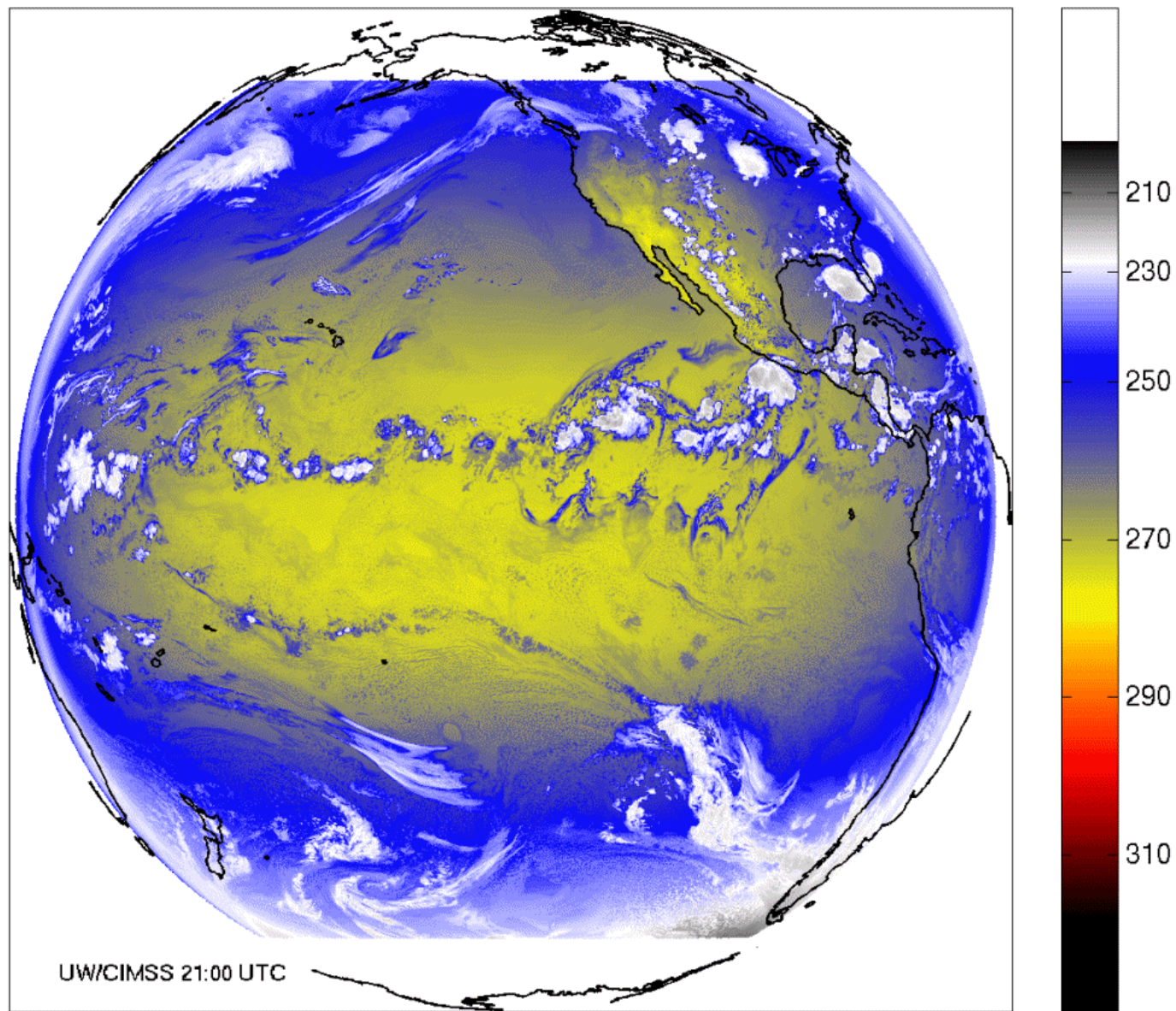
Band 10: Lower mid-level tropospheric water vapor band– moisture, flow, winds ³¹

ABI band 11 (8.5 μm) BT (K) 2008-06-26



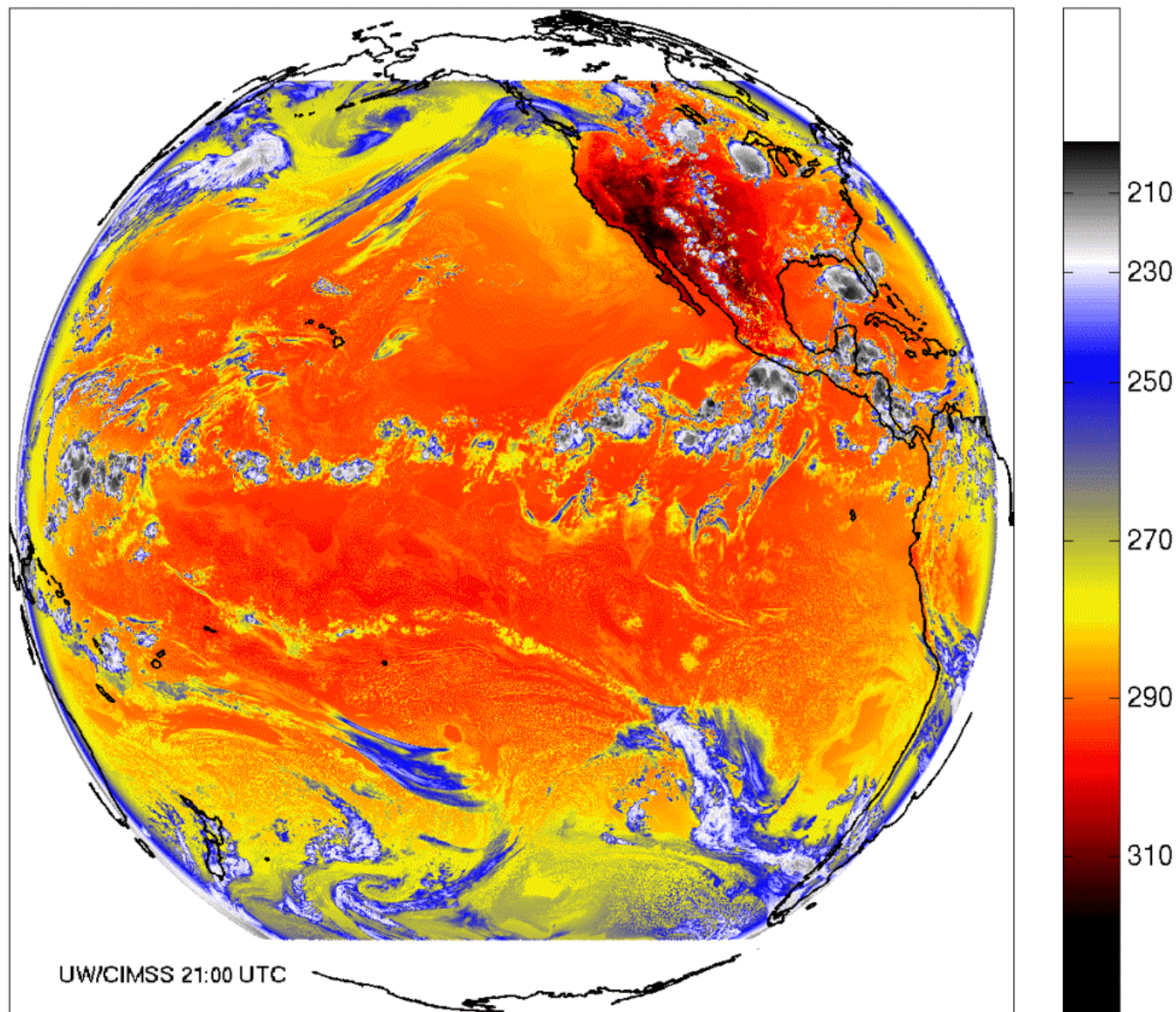
Band 11: “Cloud-top phase” band – SO_2 , dust, SST, stability indices, etc.

ABI band 12 (9.6 μm) BT (K) 2008-06-26



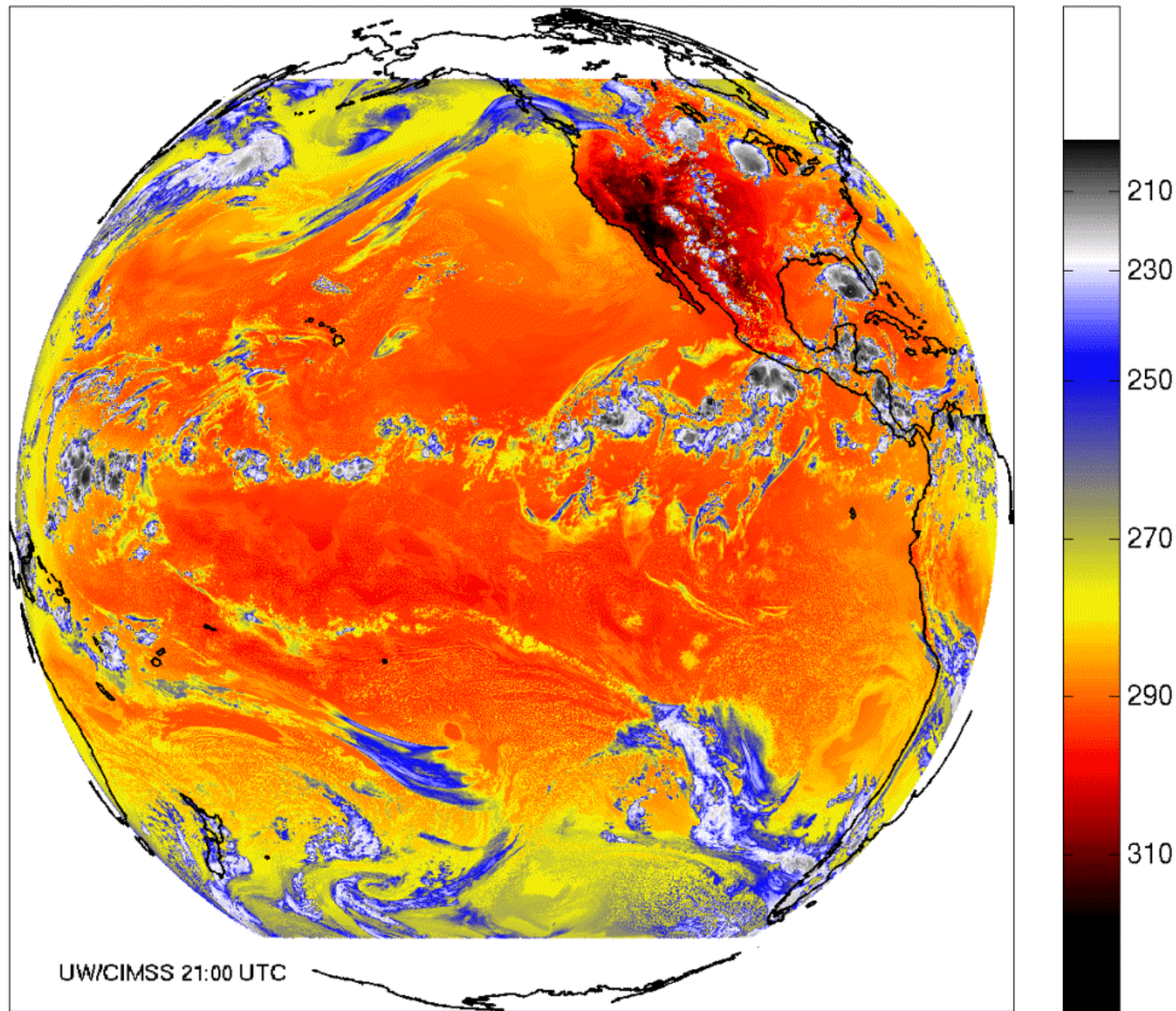
Band 12: "Ozone" band

ABI band 13 (10.4 μm) BT (K) 2008-06-26



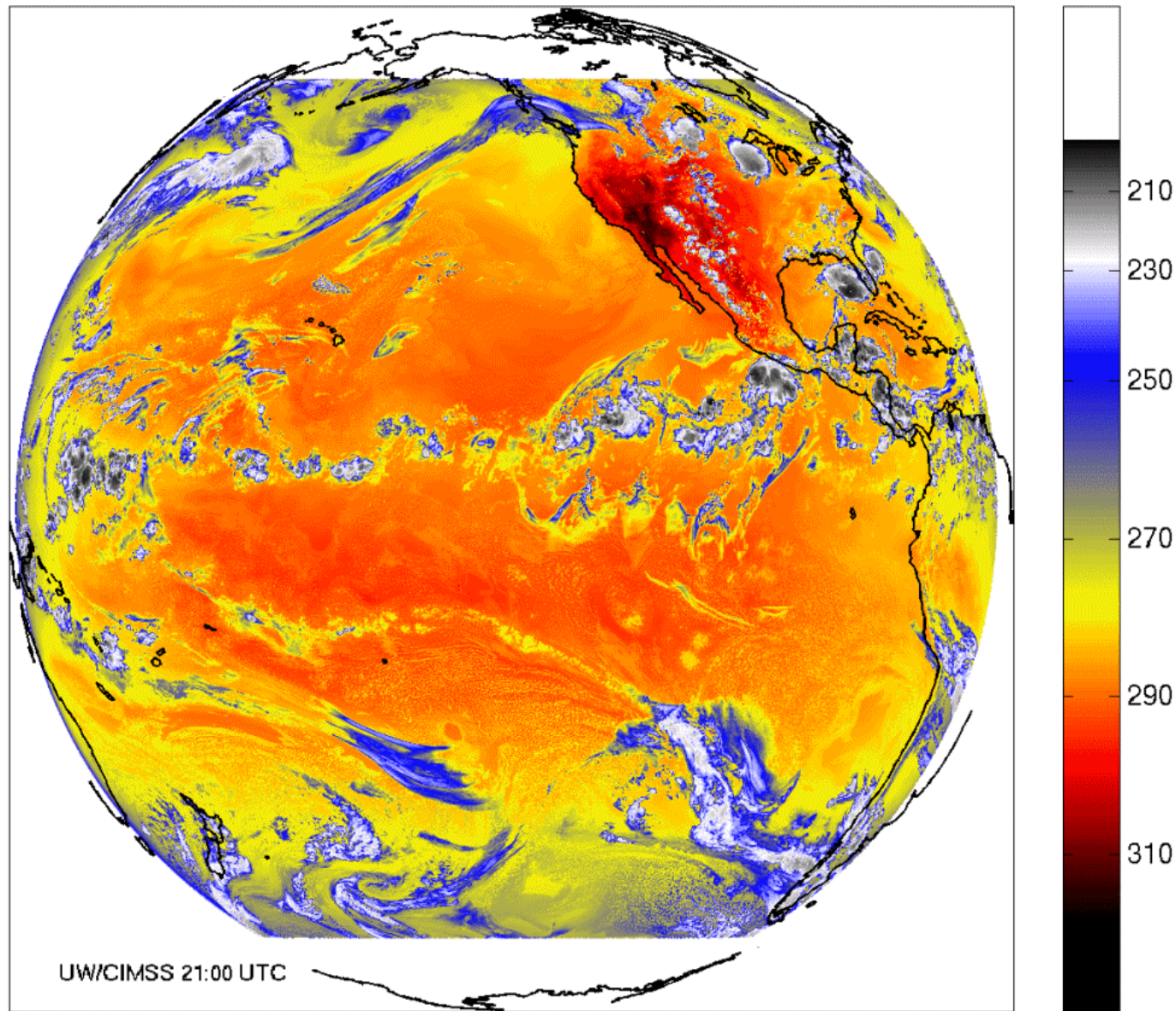
Band 13: “Clean” IR longwave window band – imagery, TPW, etc.

ABI band 14 (11.2 μm) BT (K) 2008-06-26



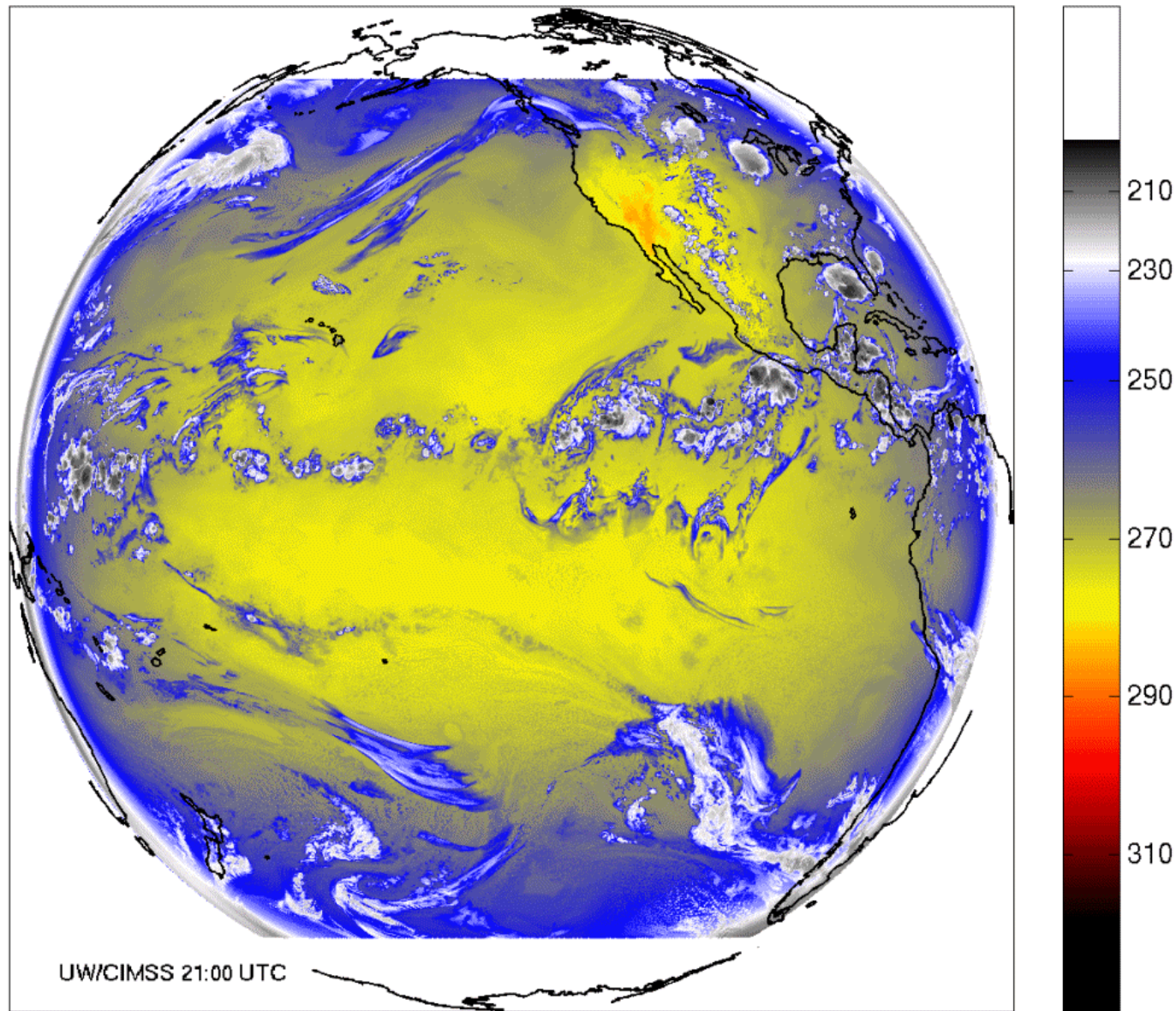
Band 14: IR longwave window band – many cloud parameters, SST, snow cover ³⁵

ABI band 15 (12.3 μm) BT (K) 2008-06-26



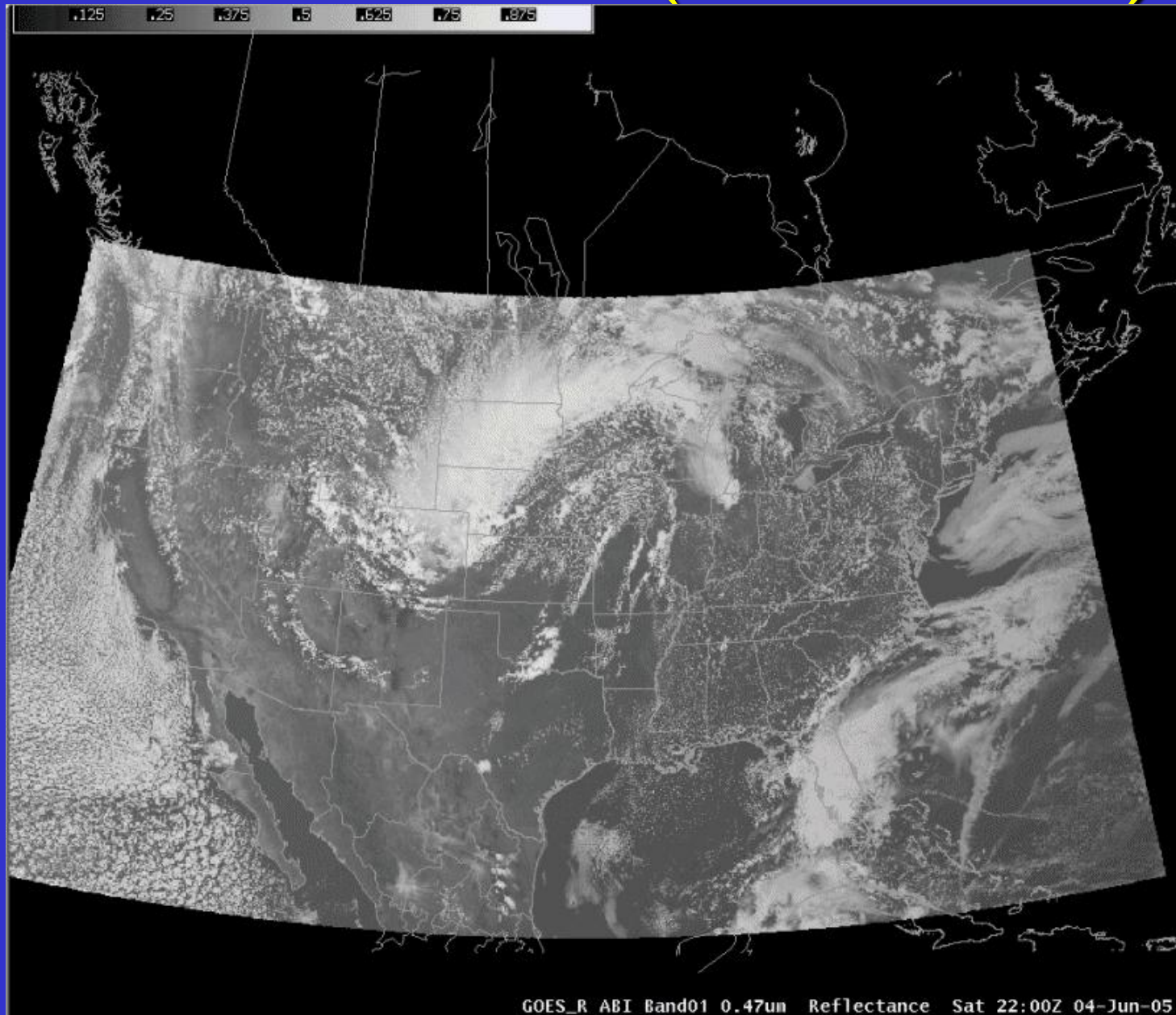
Band 15: “Dirty” IR longwave window band – many cloud parameters, TPW 36

ABI band 16 (13.3 μm) BT (K) 2008-06-26



Band 16: "CO₂" longwave IR band – cloud height/pressure, stability indices³⁷

ABI in AWIPS (via netCDF)

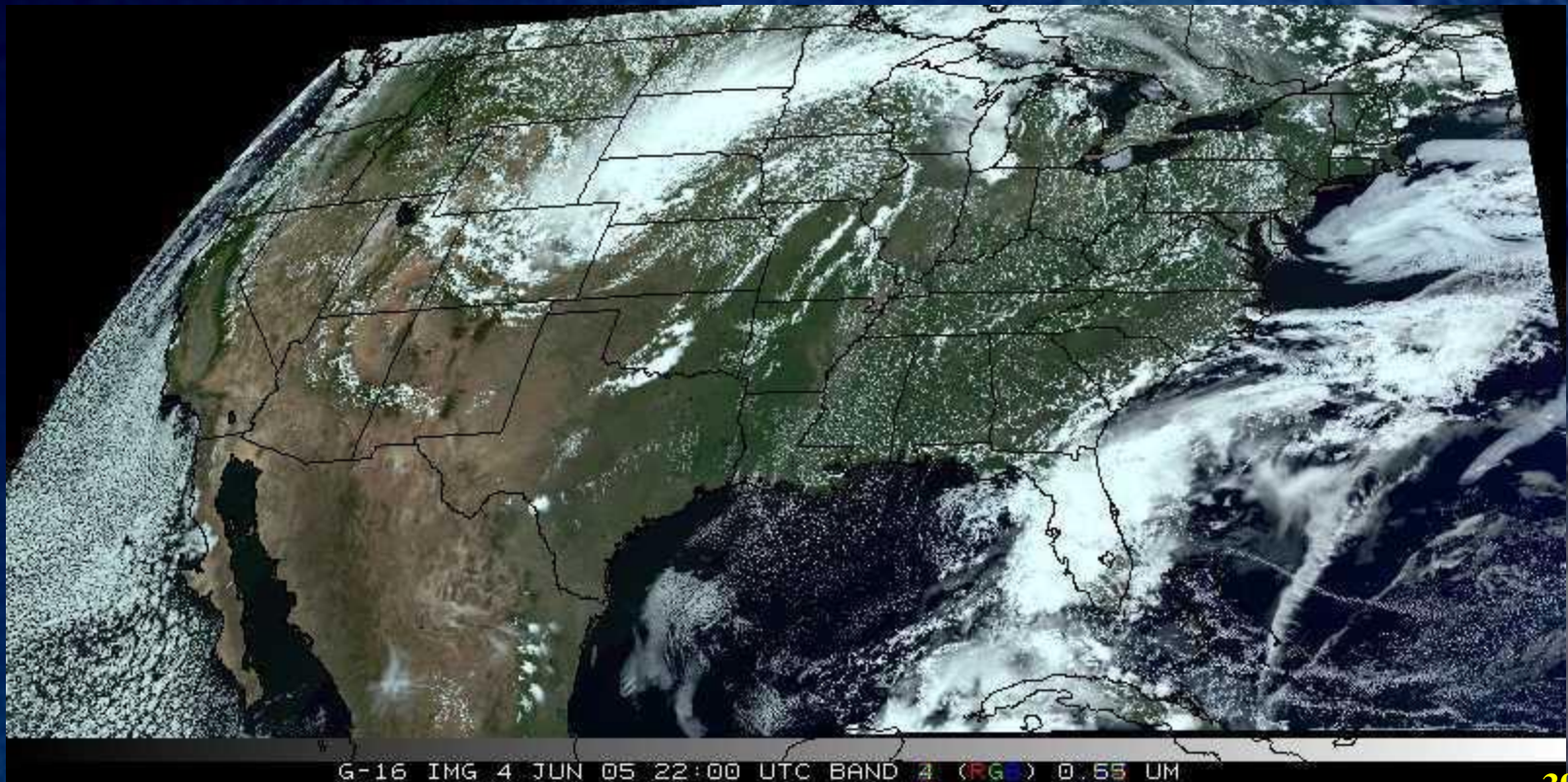


Simulated Advanced Baseline Imager (ABI) bands shown; in the legacy AWIPS.

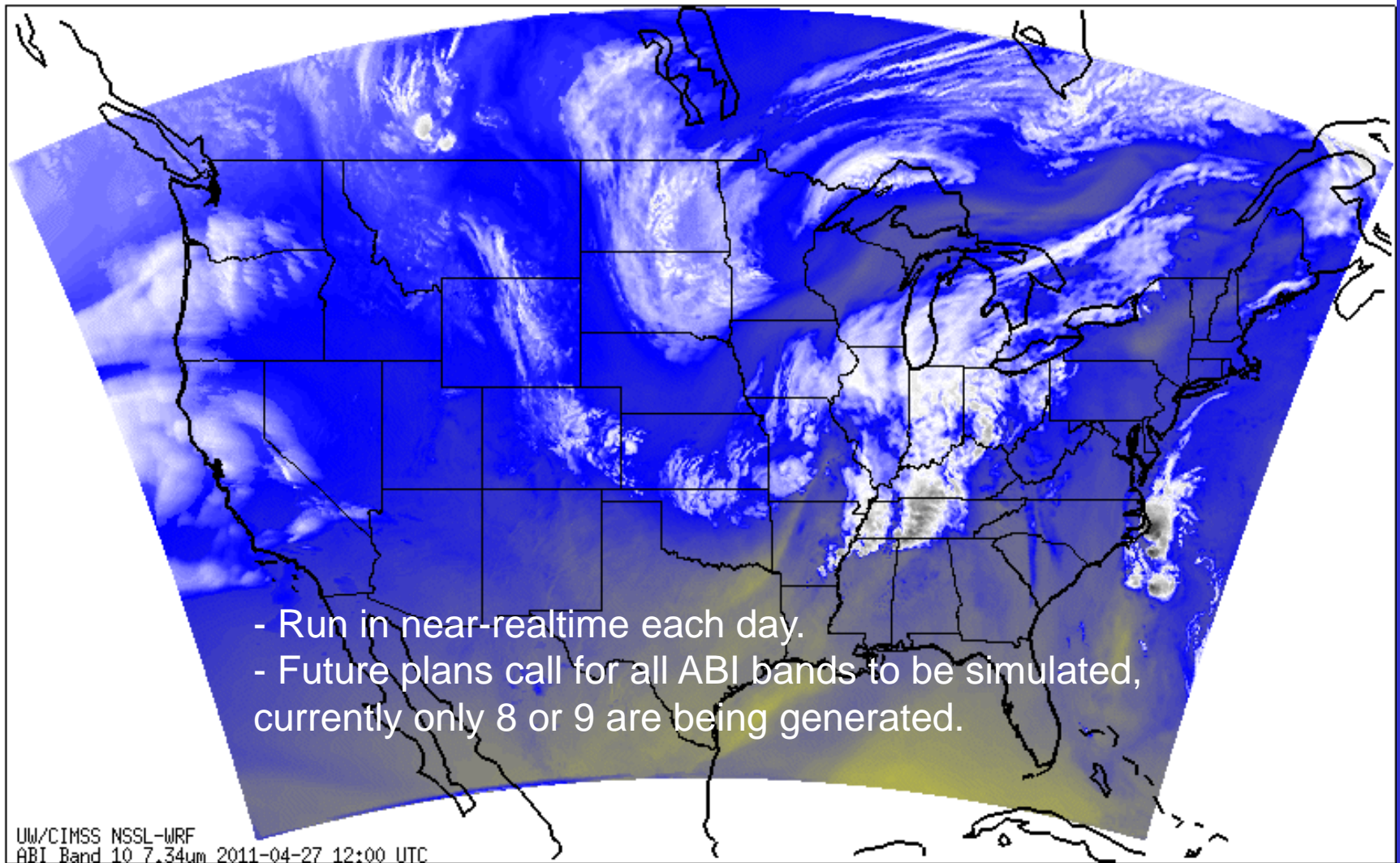


Visualization ("decision aid")

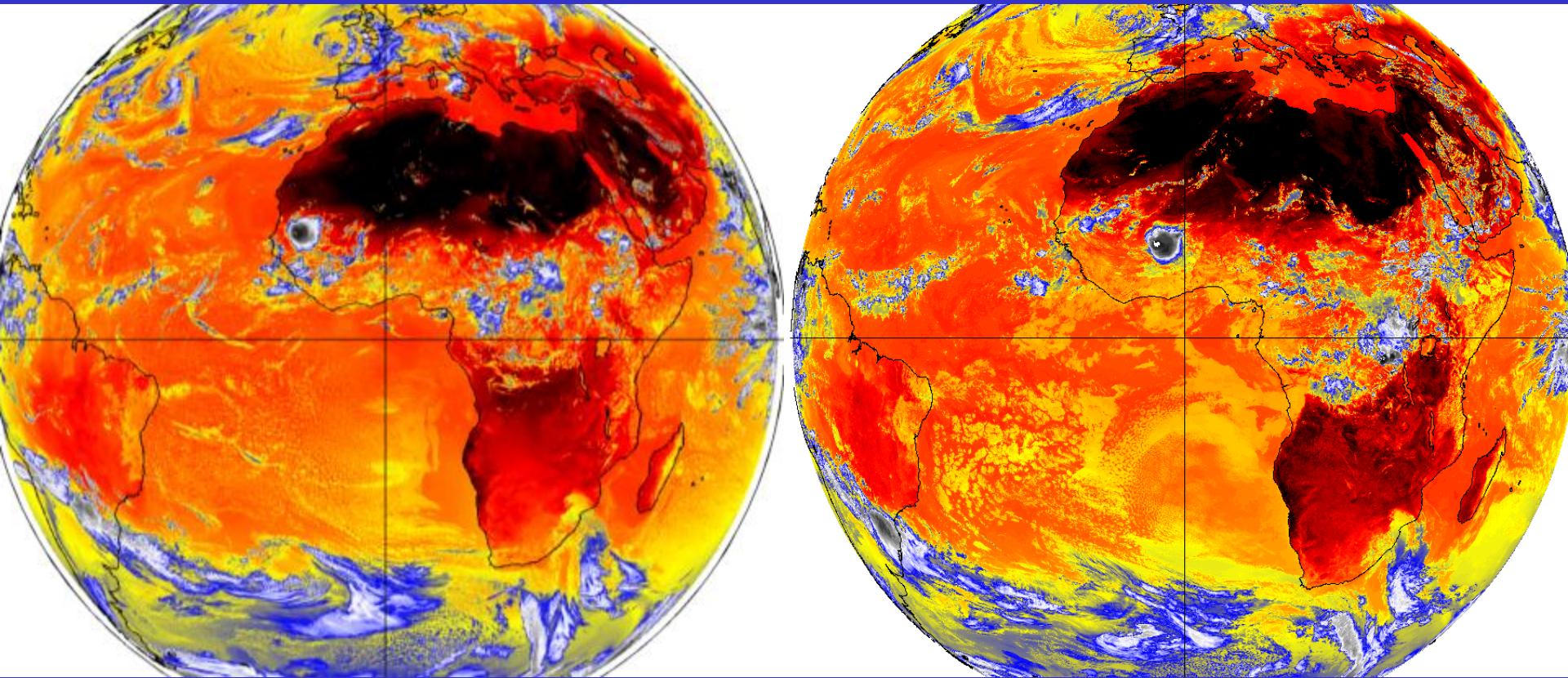
- "True Color" with "synthetic" green from ABI simulated data (from CIMSS); image from Don Hillger, RAMMB.



Simulated ABI band – NSSL WRF



WRF Model-Derived Proxy Radiance Datasets (UW CIMSS)



- Which is which – Proxy/Observed or Observed/Proxy SEVIRI 10.8 μm Tb?



GOES-R Products



Baseline Products

Advanced Baseline Imager (ABI)

Aerosol Detection (Including Smoke and Dust)
Aerosol Optical Depth (AOD)
Clear Sky Masks
Cloud and Moisture Imagery
Cloud Optical Depth
Cloud Particle Size Distribution
Cloud Top Height
Cloud Top Phase
Cloud Top Pressure
Cloud Top Temperature
Derived Motion Winds
Derived Stability Indices
Downward Shortwave Radiation: Surface
Fire/Hot Spot Characterization
Hurricane Intensity Estimation
Land Surface Temperature (Skin)
Legacy Vertical Moisture Profile
Legacy Vertical Temperature Profile
Radiances
Rainfall Rate/QPE
Reflected Shortwave Radiation: TOA
Sea Surface Temperature (Skin)
Snow Cover
Total Precipitable Water
Volcanic Ash: Detection and Height

Geostationary Lightning Mapper (GLM)

Lightning Detection: Events, Groups & Flashes

Space Environment In-Situ Suite (SEISS)

Energetic Heavy Ions
Magnetospheric Electrons & Protons: Low Energy
Magnetospheric Electrons: Med & High Energy
Magnetospheric Protons: Med & High Energy
Solar and Galactic Protons

Magnetometer (MAG)

Geomagnetic Field

Extreme Ultraviolet and X-ray Irradiance Suite (EXIS)

Solar Flux: EUV
Solar Flux: X-ray Irradiance

Solar Ultraviolet Imager (SUVI)

Solar EUV Imagery

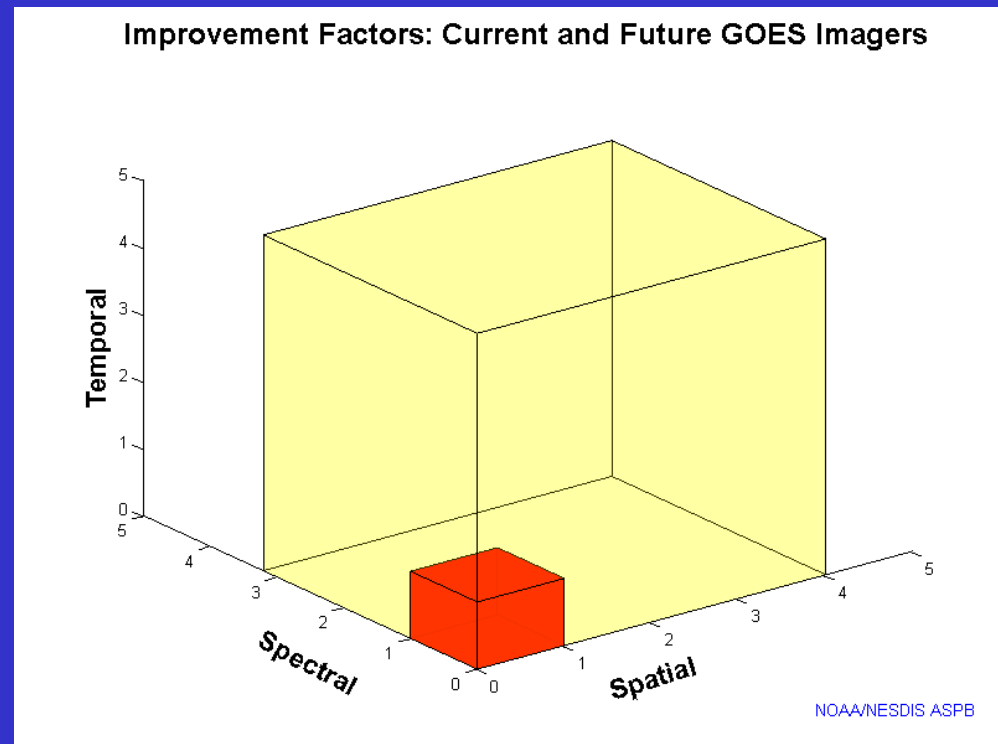
Future Capabilities

Advanced Baseline Imager (ABI)

Absorbed Shortwave Radiation: Surface
Aerosol Particle Size
Aircraft Icing Threat
Cloud Ice Water Path
Cloud Layers/Heights
Cloud Liquid Water
Cloud Type
Convective Initiation
Currents
Currents: Offshore
Downward Longwave Radiation: Surface
Enhanced "V"/Overshooting Top Detection
Flood/Standing Water
Ice Cover
Low Cloud and Fog
Ozone Total
Probability of Rainfall
Rainfall Potential
Sea and Lake Ice: Age
Sea and Lake Ice: Concentration
Sea and Lake Ice: Motion
Snow Depth (Over Plains)
SO₂ Detection
Surface Albedo
Surface Emissivity
Tropopause Folding Turbulence Prediction
Upward Longwave Radiation: Surface
Upward Longwave Radiation: TOA
Vegetation Fraction: Green
Vegetation Index
Visibility

Outline

- Current GOES Imager and Sounder
 - GOES-14/15
- ABI (Advanced Baseline Imager)
 - Temporal
 - Spatial
 - Spectral
- **Summary**
 - More information
 - Questions

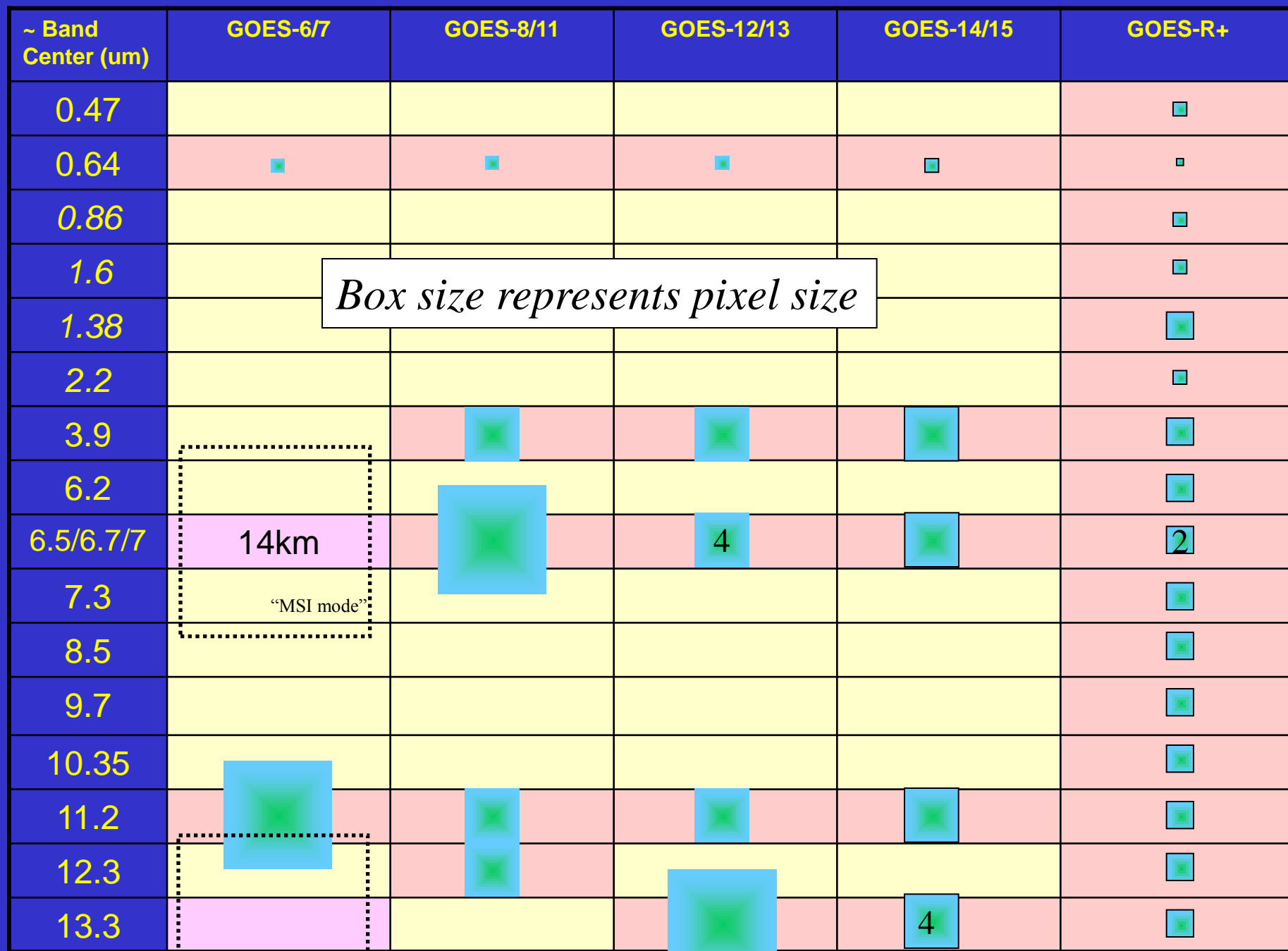


Approximate spectral and spatial resolutions of US GOES Imagers

Visible

Near-IR

Infrared



Summary



- The ABI on GOES-R will improve over the current instruments (spectrally, spatially and temporally), plus improved image navigation and registration and radiometer performance.
- These improvements will greatly assist a host of applications and new products.
- Contact information:
 - tim.j.schmit@noaa.gov

More information

GOES-R:

- <http://www.goes-r.gov>
- <http://www.meted.ucar.edu/index.htm>
- http://cimss.ssec.wisc.edu/goes_r/proving-ground.html



GOES and NASA:

- <http://goespoes.gsfc.nasa.gov/goes/index.html>
- <http://goes.gsfc.nasa.gov/text/goes.databookn.html>

UW/SSEC/CIMSS/ASPB:

- http://cimss.ssec.wisc.edu/goes_r/proving-ground/nssl_abi/nssl_abi_rt.html
- http://cimss.ssec.wisc.edu/goes_r/awg/proxy/nwp/
- <http://cimss.ssec.wisc.edu/goes/abi/>
- <http://cimss.ssec.wisc.edu/goes/abi/wf>
- <http://cimss.ssec.wisc.edu/goes/blog/>
- <http://www.ssec.wisc.edu/data/geo/>

AMS BAMS Article on
the ABI (Aug. 2005)



Acknowledgements



- The authors would like to thank the entire GOES-R team (especially the GOES-R Program Office); within the government, industry and academia.
- The views, opinions, and findings contained in this presentation are those of the author and should not be construed as an official National Oceanic and Atmospheric Administration or U.S. Government position, policy, or decision.

